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A Basin-Specific Characterization of the Subsurface Geology of Potential Reservoir Locations in George County, Mississippi

Adam D. Lenz

A basin-specific characterization of the subsurface geology of potential reservoir locations in George County, Mississippi

By

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The preliminary assessment for reservoir sites in George County targeted three basins within the county as the initial focus of the research study: Big Creek, Big Cedar Creek, and Escatawpa River basins. As a portion of the reservoir study, this study was a basin-specific geological assessment of the three basins within George County through literature review, well log correlation, and a county wide spring inventory. The goal of this study was to obtain and interpret subsurface data in order to develop detailed geologic maps and stratigraphic cross sections which aided in the site assessment and characterization of the geologic and hydro-geologic suitability of potential reservoir sites. This study concluded that the hypothesis was proved and all three selected drainage basins were potentially geologically suitable to sustain a large reservoir, therefor other factors should be taken into account to determine specific reservoir location such as stream discharge and water quality.

DEDICATION

To my family and friends who have been so helpful and supportive throughout my graduate study.

ACKNOWLEDGEMENTS

I would like to thank Dr. Darrel Schmitz for all of his guidance and support throughout not only this project, but my entire college career at Mississippi State University. I would also like to thank my other committee member Dr. James May and Dr. Karen McNeal who have been very supportive and helpful on this in my graduate studies. A special thanks to the MDEQ office of Geology, and office of Land and Water Resources along with the George County Board of Supervisors as well as Pickering Engineering Firm and Pat Harrison Waterways District. I would also like to thank our research group team members who have helped with this project the past two years as well as my family and friends who have been very supportive. This material is based upon work supported by the National Science Foundation under Grant No. DGE-0947419 at Mississippi State University. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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CHAPTER I

INTRODUCTION

The Regular Session of the Mississippi State Legislature passed House Bill 1351 Section 3(1)(a) in year 2010, which established a special fund titled the "Pat Harrison Waterway Lake Improvement Fund". Through this bill, funds were designated to initiate the construction of a reservoir lake in George County, Mississippi that would serve primarily for industrial water storage and secondarily for public recreation. The following research was done as part of a larger research project determining the suitability of potential reservoir locations in George County, Mississippi. All goals, methods, and practices were done to meet and fulfill any and all requirements of the George County Lake Project guidelines.

This study targeted three basins within the county: Big Creek, Big Cedar Creek, and the Escatawpa River basin (Figure #7) for the focus of the work. These drainage basins where chosen to be the focus for the scope of work for this study and the George County Reservoir Lake Project based the following characteristics: size of the basin, determination of containment within George County, potential land use and development, obvious significant infrastructure, current land uses, protected or scenic designations, potentially suitable geology, and low flow conditions within the basins. As a portion of the George County Lake Project, the goal of the proposed study is to obtain and interpret subsurface data in order to develop detailed geologic maps and stratigraphic cross sections of the above stated drainage basins which will serve as an aid in the site assessment and characterization of the geologic and hydro-geologic suitability of potential reservoir sites.

CHAPTER II

SETTING

Location

George County (Figure #2) is located within the Lower Mississippi Coastal Plain region (Figure #1), where it is greatly influenced by the coastal semitropical climate, having an average, 50 to 60 degree Fahrenheit winter temperature, 85 to 95 degrees Fahrenheit summer temperature, and 64 inches of rainfall annually. Furthermore, George County has an average elevation of 50 feet above sea level, lies within the Pascagoula River Drainage Basin, and is geologically dominated by shallow marine, near-shore deposits of middle to late Miocene age. The county covers 483 square miles, of which more than 70 percent is characterized as commercial forest (Southern, 2007; Williams et. al, 1967).

State Geology Map of Mississippi

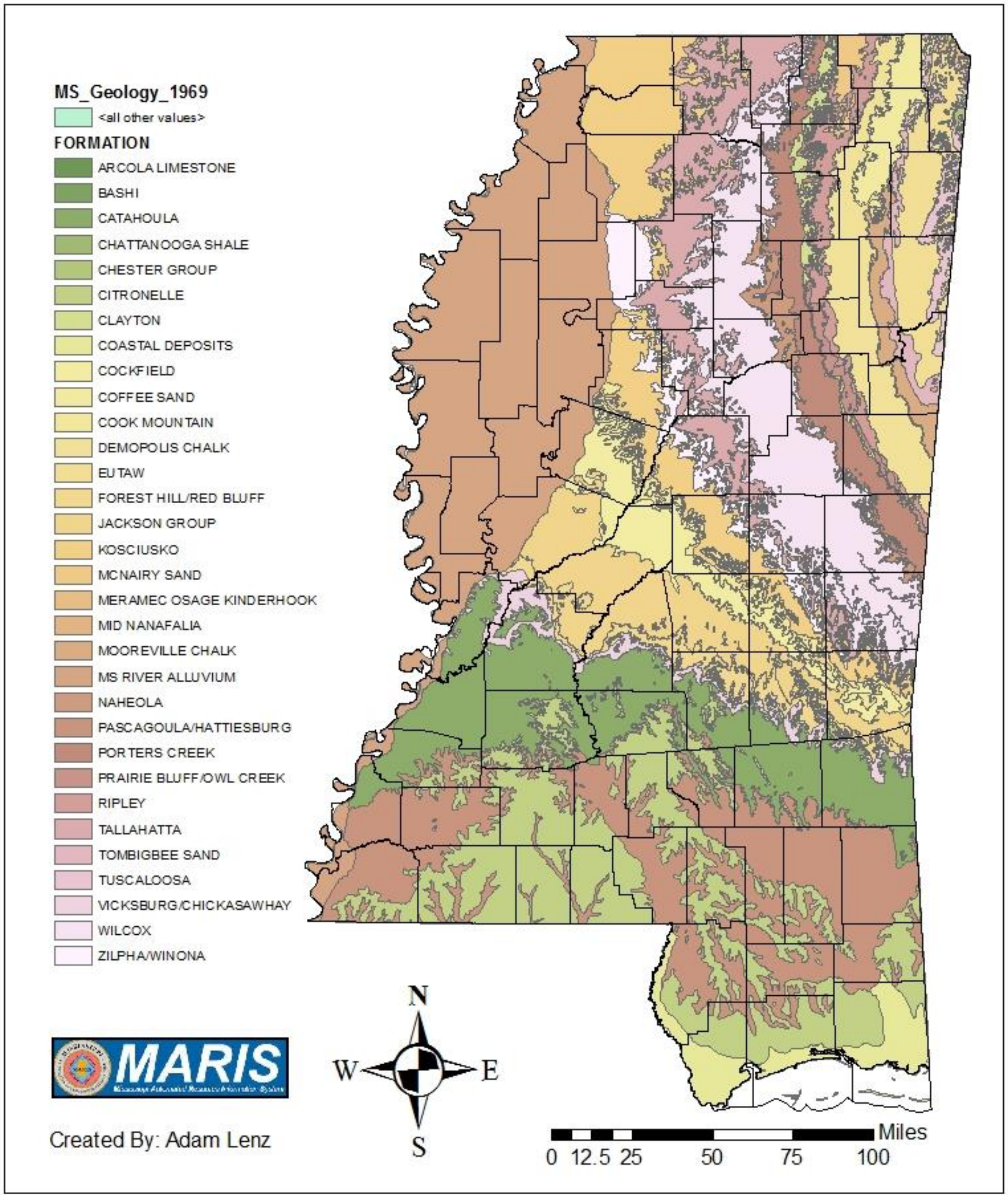

Figure 1 State Geology Map of Mississippi

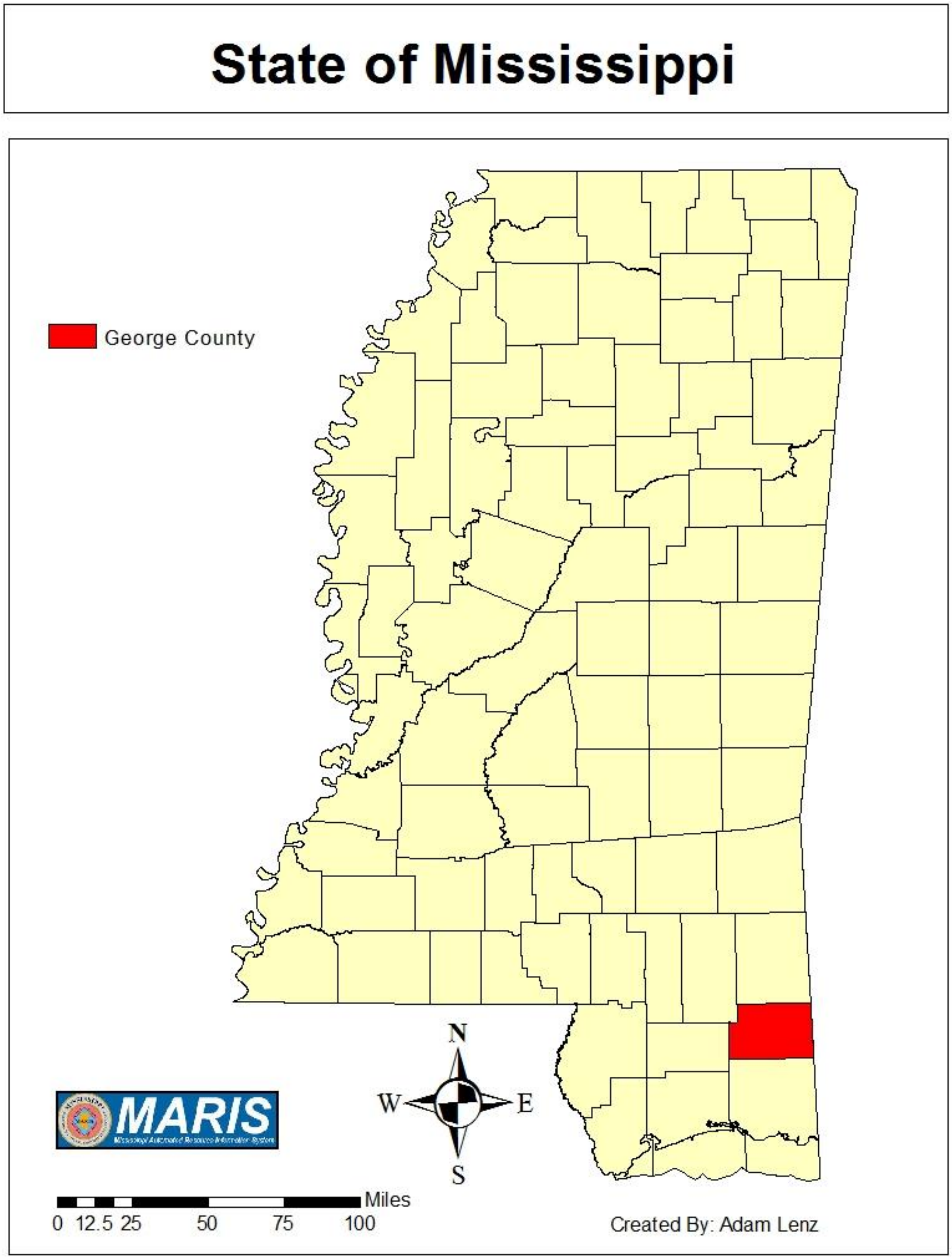

Figure 2 Mississippi Counties Map

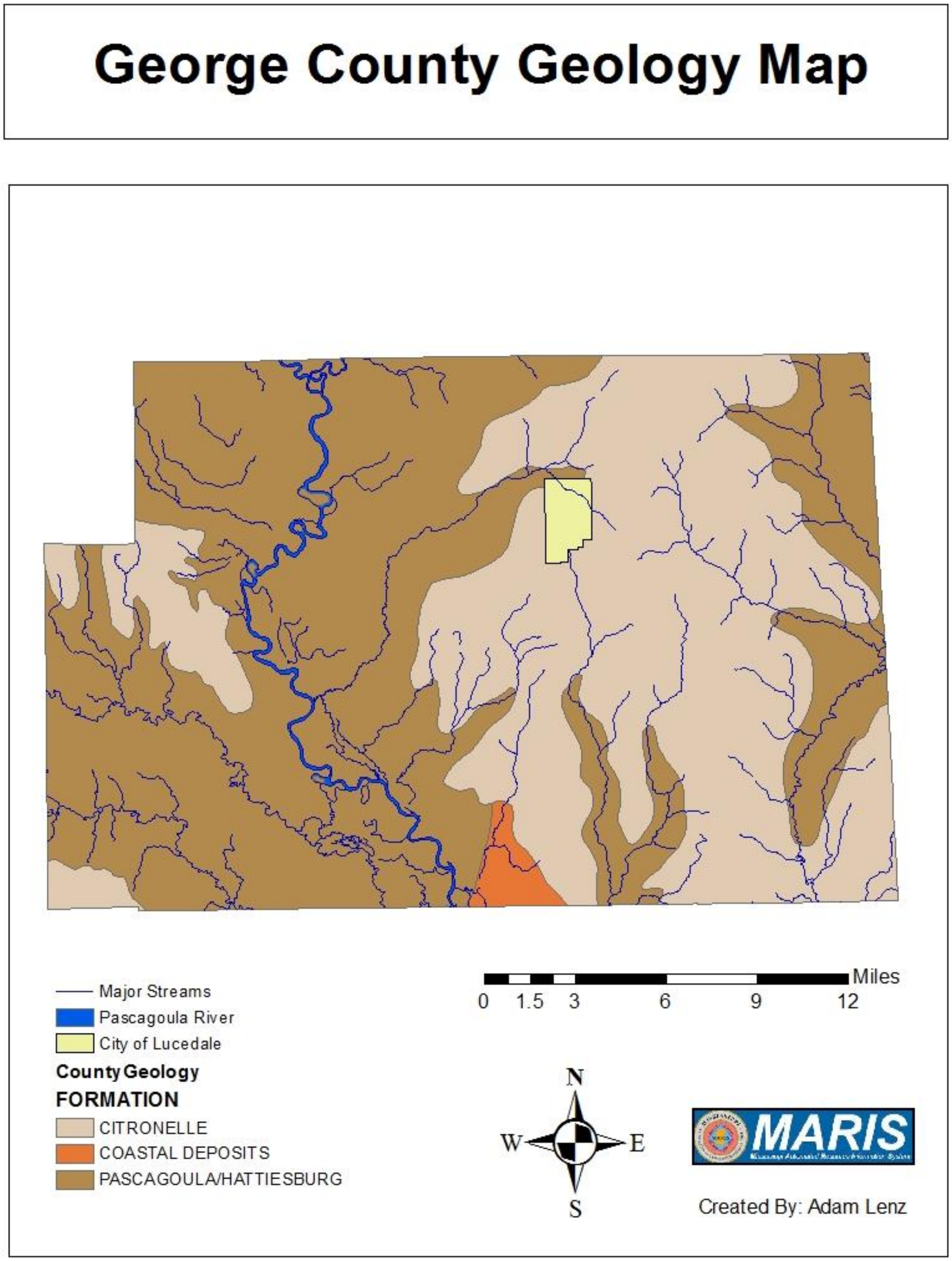

Figure 3 George County Geology Map

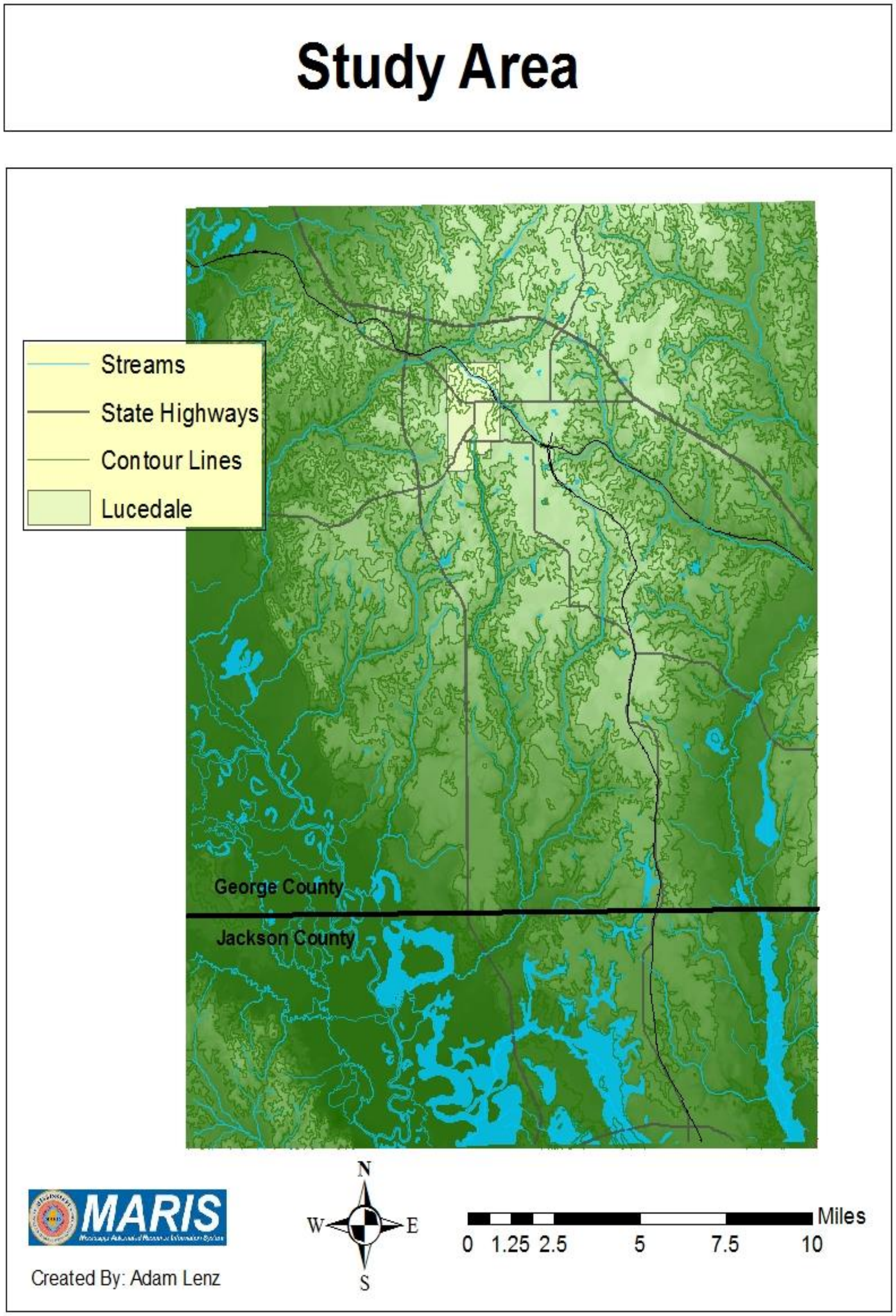

Figure 4 Study Area Map

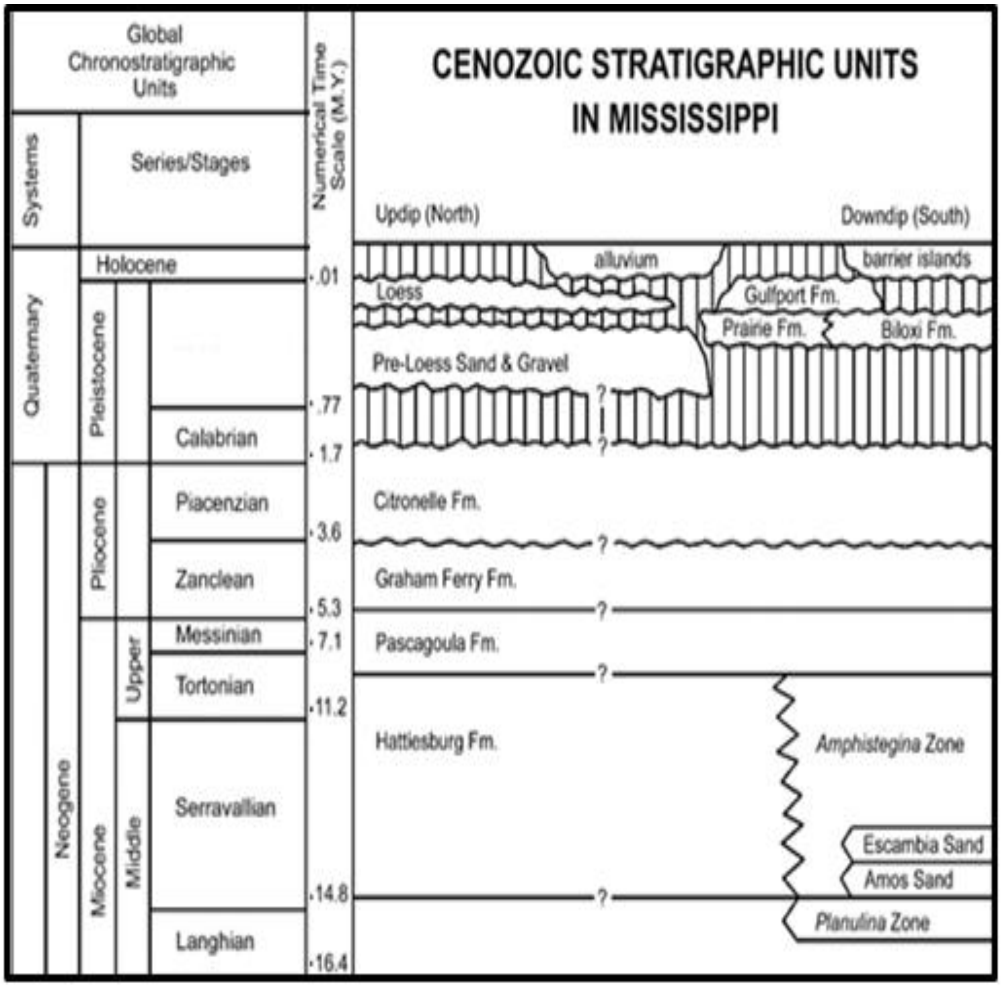

Figure 5 Stratigraphic Column of Formations from Units in George County

Topography and Geomorphology

George County consists of moderately hilly and rolling topography ranging from an elevation of approximately 300 feet above sea level in the North Eastern region of the county to 20 feet above sea level along the Pascagoula River in the South Central region of the County. Much of the topography is greatly influenced by the deep stream cuts eroding away the loosely compacted younger deposits at the surface. Larger rivers and streams in the county leave a very distinguishable cut “deep valley’s with broad valley flats". Smaller tributary streams cut a narrower deep ravine which is very noticeable on the surface and in cross sections throughout the county (Williams et. al, 1967).

There are two major rivers in George County that run through George County; The Pascagoula River which enters the county along the Northern border, west of center flowing south and exiting the county along the southern border in the center of the county, while the Escatawpa River which flows in the county on the eastern border of George County flowing southwest and exiting in the southeastern part of the Southern border of George County. The study area consists of the all sections in George County east of the Pascagoula River and the northern most sections of Jackson County were the selected as drainage basins exit George County.

Structure

George County, Mississippi is regionally located near multiple historic geologic features (figure #6) which dates back to as far as rifting from the break-up of Pangea during the late Triassic. The Gulf of Mexico basin formed on a divergent margin that was exposed to tectonic rifting and wrench faulting along with phases of crustal extension, sea-floor spreading, and thermal subsidence. There is extensive east-west trending of Jurassic age (200 Mya.) normal faulting from the Lower Mobile Bay fault system present in offshore Alabama, extending inland into younger Cretaceous age (100 mya) sediments (Mancini et al., 1992). Lows and highs formed as a result of Late Paleozoic continental collision and late Triassic - early Jurassic rifting. The positive basement features are consistent with continental blocks formed by rifting while the negative features are interpreted to be basement depressions formed from crustal extension between continental blocks. The basement surface had been dissected by wrench faulting associated with grabens (Mancini et al., 1999). Widespread salt movement during the Jurassic age created a complex array of salt-related structures such as diapirs, anticlines, graben systems (Mancini and Tew, 1990).

Located approximately 40 miles inland from the present day Gulf of Mexico, George County lies at the southern edge of the Mississippi Interior Salt Basin and East Mississippi Syncline, north of the axis of the Gulf Coast Geosyncline and Lower Mobile Bay Fault System, west of the axis of the Mobile Graben, and is crosscut east to west by the Wiggins Anticline and Arch (figure #6). Minor evidence of these structural features is present in the subsurface of George County. Geologic cross-sections of George County constructed by Williams et al. (1967) show no distinctive evidence of structural deformation associated with faulting or folding in the subsurface.

Structural maps of the Lower Tuscaloosa Formation show the Wiggins Anticline plunging southwestward across George County and entering from the northeast. Williams et al. (1967) describe Wiggins Anticline as being formed between the Late Cretaceous and Late Tertiary (10-80 mya). The formation is dominated by thick sediment accumulation and subsidence in the north to form the East Mississippi Syncline with thinning sediment supply near George County. However, during later stages a gradual shift of sediment deposition to the south took place causing the development of the Gulf Coast Geosyncline. Williams et al. describes the Wiggins Anticline as a westward nosing causing the Pascagoula river alluvial plain to be “bowed to the west in George County closely following the plunge of the Wiggins Anticline” (1967).

The Mississippi Interior Salt Basin in Mississippi and Alabama was a large, subsiding depocenter throughout the Jurassic and into the early Cenozoic (Mancini et al., 1992; Mancini and Tew, 1990). The Mobile Graben is a major subsurface salt withdrawal feature that trends north-south and defines the eastern limit of the Mississippi Interior Salt Basin. Contrary to interpretations of Williams et al. (1967), Tew et al. (1991) incorporate research of older strata to describe the Wiggins Arch and Hancock Ridge. Wiggins Arch to represent an uplifted horst block related to extension and rifting of the continental margin of North America during the late Triassic. During the Jurassic, transgression of the Gulf of Mexico, the Wiggins Arch structure allowed for thick evaporites to be retained and deposited within the Mississippi Interior Salt Basin. Deposition of salt pillows are consistently associated with the basin rises with salt diapirs forming near the basin center (Tew et al., 1991). The Jurassic Smackover Formation was the earliest carbonate unit deposited in the Mississippi Interior Salt Basin during a transgression -regression cycle. However, as basin filling and regression began, the Wiggins Arch formed a platform barrier between the basin and open marine conditions resulting in the end of carbonate production and Smackover deposition within the basin. The barrier effects created by the Wiggins Arch allowed for siliciclastic, evaporitic, and carbonate deposits to form landward in the restricted environment while dense, dark micritic limestones were limited to the distal offshore ramp (Mancini et al., 1999). The Lower Mobile Fault System is a regional basement rift trend that formed in response to the breakup of Pangea and the opening of the Gulf of Mexico. The fault system is thought to have formed along with the deposition of the Late Triassic – Early Jurassic Eagle Mills Formation (Mink et al., 1991).

Seismic Activity

The state of Mississippi has been the center of only a few earthquakes throughout history; however, the state has been affected numerous times by earthquakes originating in neighboring states. In 1811 and 1812, several earthquakes occurred along the New Madrid Fault in Missouri. Within Mississippi, the first and most severe earthquake recorded was centered near Charleston on December 16, 1931. The earthquake's shocks were observed over an area of 65,000 mile area. A minor earthquake was reported along the Mississippi Gulf Coast on February 1, 1955. Rattling of windows and creaking of buildings were the main affects witnessed along the coast. On June 4 and June 29 of 1967, two earthquakes occurred near Greenville, Mississippi. The earthquake on June 4 measured a 3.8 magnitude on the Richter Scale and affected an area of 25,000 square miles. On June 29, the second earthquake measured a magnitude of 3.4. Later, another earthquake occurred near New Madrid, Missouri on March 29, 1972 and reached an intensity of IV in northern parts of Mississippi (Von Hake, 2009). The last recorded earthquake in Mississippi occurred near the town of Olive Branch on June 2, 2008. The earthquake was given a magnitude of 2.2 and determined to be associated with the New Madrid Fault (United, 2010). Today, the New Madrid Fault system still remains the major source of future seismic activity with potential to affect Mississippi. Therefore, the United States Geological Survey currently rates George County, Mississippi with a seismic hazard of 0.02 - 0.04 g (Figure #6) (United, 2009).

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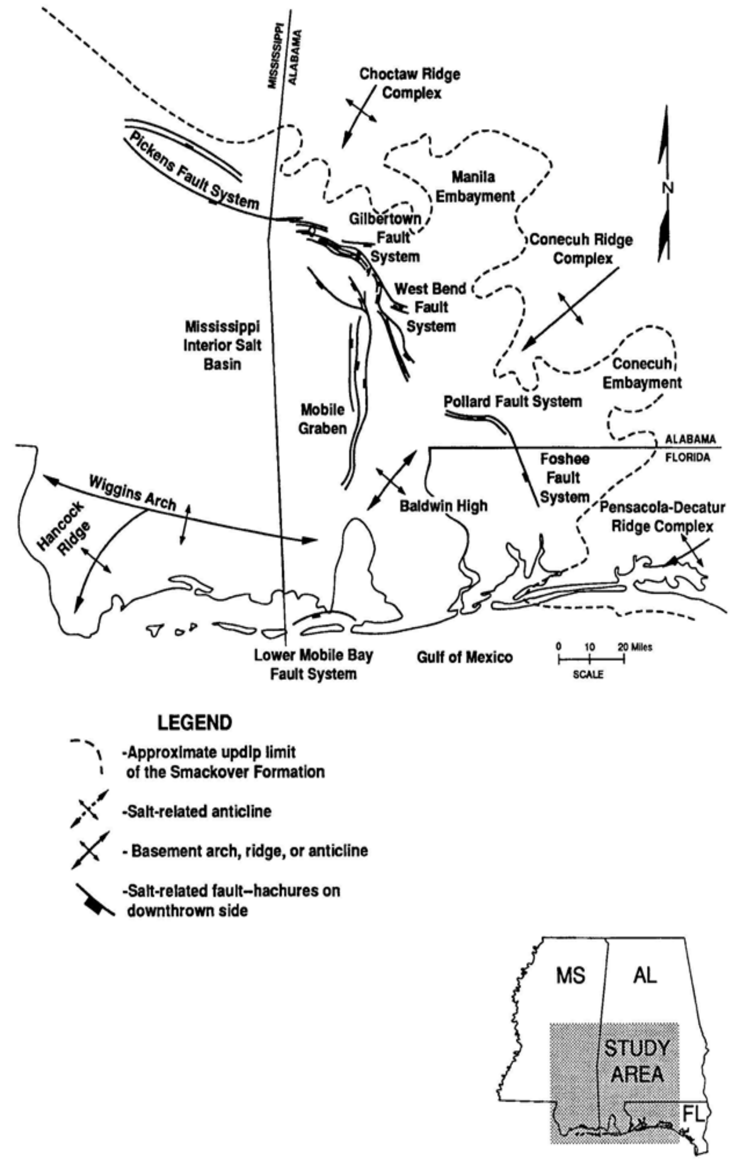

Figure 1. Location map illustrating major structural features in the eastern Gulf Coastal Plain.

Figure 6 tructure Map of Gulf Coast Region of Mississippi and Alabama

Geology

Surface geology within the study area is dominated by the Pliocene Pliestocene age (5 Mya) Citronelle Formation. The Citronelle Formation is “composed of gravel and sandstone with a few thin layers of silt or clay. The contact zone with the underlying Pascagoula Formations is an easily recognized regional unconformity, marked by a thin, dark-brown to black, iron-cemented sand". (Li and Meylan, 1994). The Citronelle Formation lies in the highest elevations of the study area between the major rivers in the North and Central portions of the study area and where it has not been completely eroded away in stream drainage areas.

Younger units including low terrace and stream alluvium deposits are seen at the surface and in the shallow subsurface at the fringes of nearly all of the major streams and in the lower portions of many of the tributary streams throughout the study area. These deposits are much more localized and are not laterally extensive over the entire county unlike much of the older stratigraphic units. These deposits are composed of mostly fine sands, with some gravels and silts usually seen in a classic fining upward sequence (Williams et al. 1967).

The Miocene age Pascagoula Formation is exposed at the surface only areas where erosion from streams has cut down deep enough into the younger deposits to expose the much older Pascagoula formation. This formation is seen in the subsurface of much of the Mississippi and Alabama Gulf Coast Region dipping south-southwest. Within the study region the Pascagoula dips at an approximate rate of 10 foot per mile except in areas where the streams have eroded down into Pascagoula Formation.

CHAPTER III

LITERATURE REVIEW

Williams et al. (1967) investigated and analyzed the geology of George County, Mississippi. Williams' work included 13 months of fieldwork and a thorough review of published and unpublished material pertinent to George County. The bulletin yields a descriptive introduction into the county land usage, climate, general topography and details of the counties physiography, and subsurface geology including formation, depositional environments, and geo-structural features. Williams et al. (1967) assessed current-to-date well log and geophysical log data and all pertinent previously conducted research of the county's geology and hydrogeology. To date, Williams' work remains the most thorough description of George County geology; therefore, it will serve as the predominant literature source for describing and characterizing the geology of the basin.

Brahana and Dalsin (1977) present an elaborate water assessment of George and surrounding counties for the purpose of studying industrial development potential. Brahana and Dalsin's work focused specifically on the hydrogeology of the counties, which included water quality, water supply, and drainage data for surface and groundwater. Although the primary focus of their study was on the hydrogeology, portions of their work will be useful for the proposed study such as: establishing basin drainage boundaries, constructing stratigraphic cross sections, and interpretation of structural features of the shallow aquifers units. Brahana and Dalsin's work was published 10 years after Williams et.al (1967); therefore it included some subsurface data that were not available to Williams.

Ervin Otvos, head of the Gulf Coast Research Laboratory in Gulf Shores, Mississippi, is one of the most published researchers on Gulf Coast geology. Two publications by Otvos (1985, 2001) give great insight into Gulf Coast stratigraphy, environment of deposition, and geological descriptions. Otvos also discusses the much younger Citronelle formation, which was not described as extensively in the older literature by Brahana (1977) and Williams (1967). Otvos' works incorporate much more recent research and drill core data than that described by the previous works of Brahana (1977) and Williams et al. (1967). Although, Otvos' primary research focus was based on drill cores and surficial deposits in Jackson County, Mississippi and other coastal counties with much younger deposits than those in George County. George County exhibits these coastal deposits much less extensively, but when present, they exist as thin beds at the surface. Consequently, Otvos's research can be used as a reference for near surface deposits in George County, but may not adequately describe the deeper Pliocene age deposits that are seen more dominantly in the subsurface.

A publication by Carlson and Archfield (2009) was also reviewed as a potential reference for the basin study. Their work includes research on the J.B. Converse Reservoir in Mobile County, Alabama. The J.B. Converse Reservoir, often referred to as Big Creek Lake, lies within 50 miles of the proposed study area and in a similar geologic setting. Carlson and Archfields' work focuses on a general assessment of the reservoir and includes a very limited description of the geological and hydrogeological characteristics. This assessment does, however, discuss estimations of hydraulic conductivity values for geologic units similar to those found in George County, as well as a firm-yield-estimator, which may be useful in determining the necessary reservoir volume requirements and potential groundwater flow. At this time J.B. Converse Reservoir is the subject of further investigation and research because it exhibits a similar geologic setting.

CHAPTER IV

STATEMENT OF PROBLEM

When considering a reservoir project of this magnitude, it is important to understand the detailed subsurface characteristics of each potential reservoir location. Previous research and published literature are insufficient for a basin-specific characterization of the subsurface geology for several reasons; stratigraphic cross sections are interpretations from known surface geology maps and do not incorporate well log data, stratigraphic cross sections are delineated regionally and do not provide enough detail for basin specific geology, and stratigraphic cross sections do not incorporate the most current to-date well log data available. Because previous research and published literature were insufficient for the basin specific characterization of the geology, we conducted a preliminary investigation of the basin geology to fulfill the George County Reservoir Lake project requirements.

Objectives

The main objective of this study was to be able to make a determination regarding the suitability of the reservoir locations to be able to sustain a large reservoir by incorporating the most current data available. Research from the project yielded the construction of a detailed geologic map and stratigraphic cross sections of the three drainage basins selected for the basin study in George County. This was done by defining the extent of a confining clay layer of which could potentially sustain a large reservoir.

Hypothesis

The hypothesis for this study is that one or more drainage basins selected for this study will be geologically suitable to potentially sustain and retain water for a large reservoir in George County, Mississippi.

CHAPTER V

METHODOLOGY

Three drainage basins within George County, Mississippi; Big Creek, Big Cedar Creek, and Escatawpa River basins (Figure #4) were targeted for the initial focus research study. An examination to characterize the subsurface geologic and hydro-geologic conditions of the selected basins will yielded the geologic suitability for a potential reservoir lake in George County, Mississippi. Research for subsurface characterization of the basins consisted of an extensive literature review of George County geology, well log correlation, and a county wide spring inventory. These methods provided a better understanding of the subsurface geologic conditions within each drainage basin in order to adequately determine its potential to support a reservoir lake.

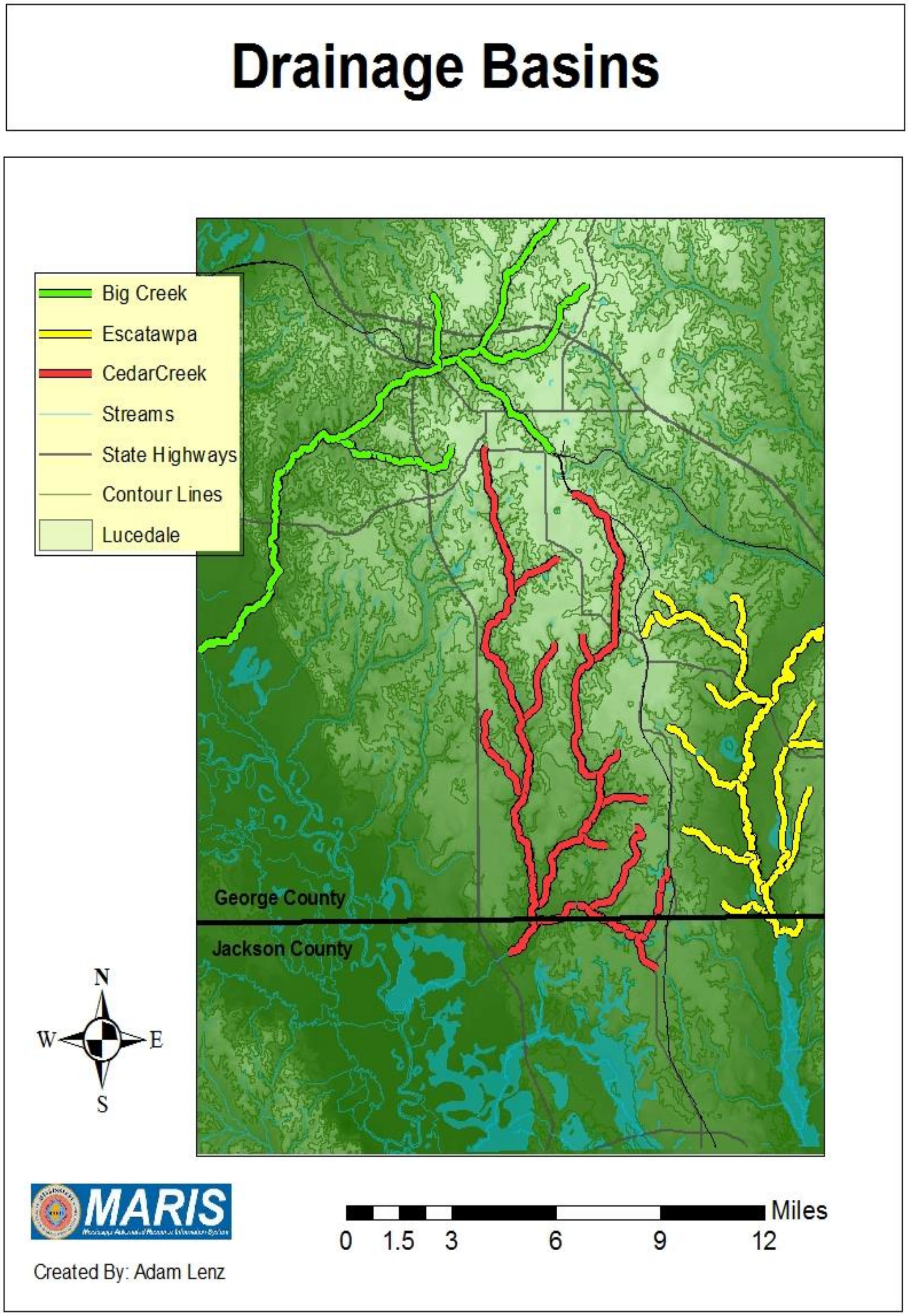

Figure 7 Drainage Basins in Study Area

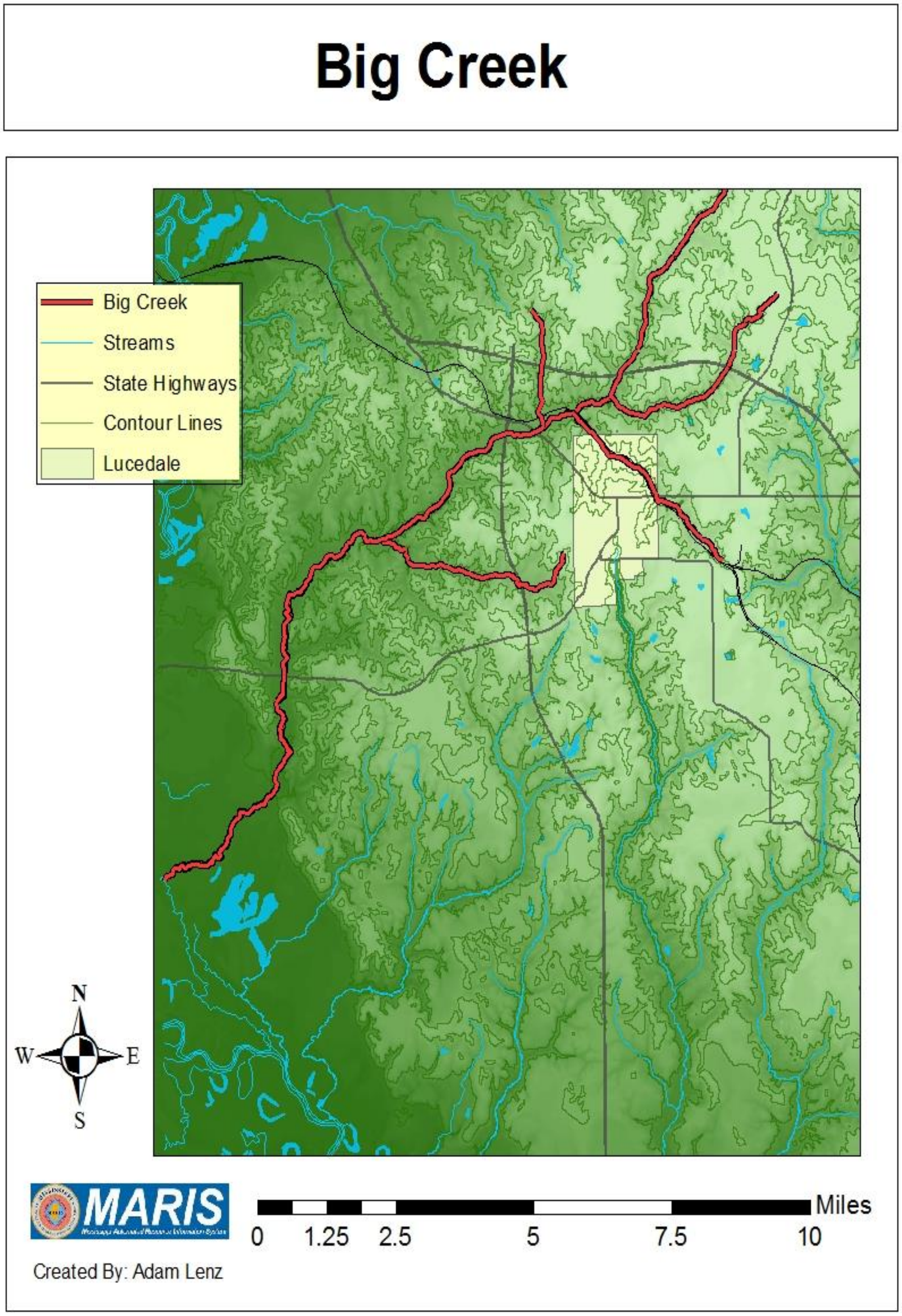

Figure 8 Big Creek Drainage Basin

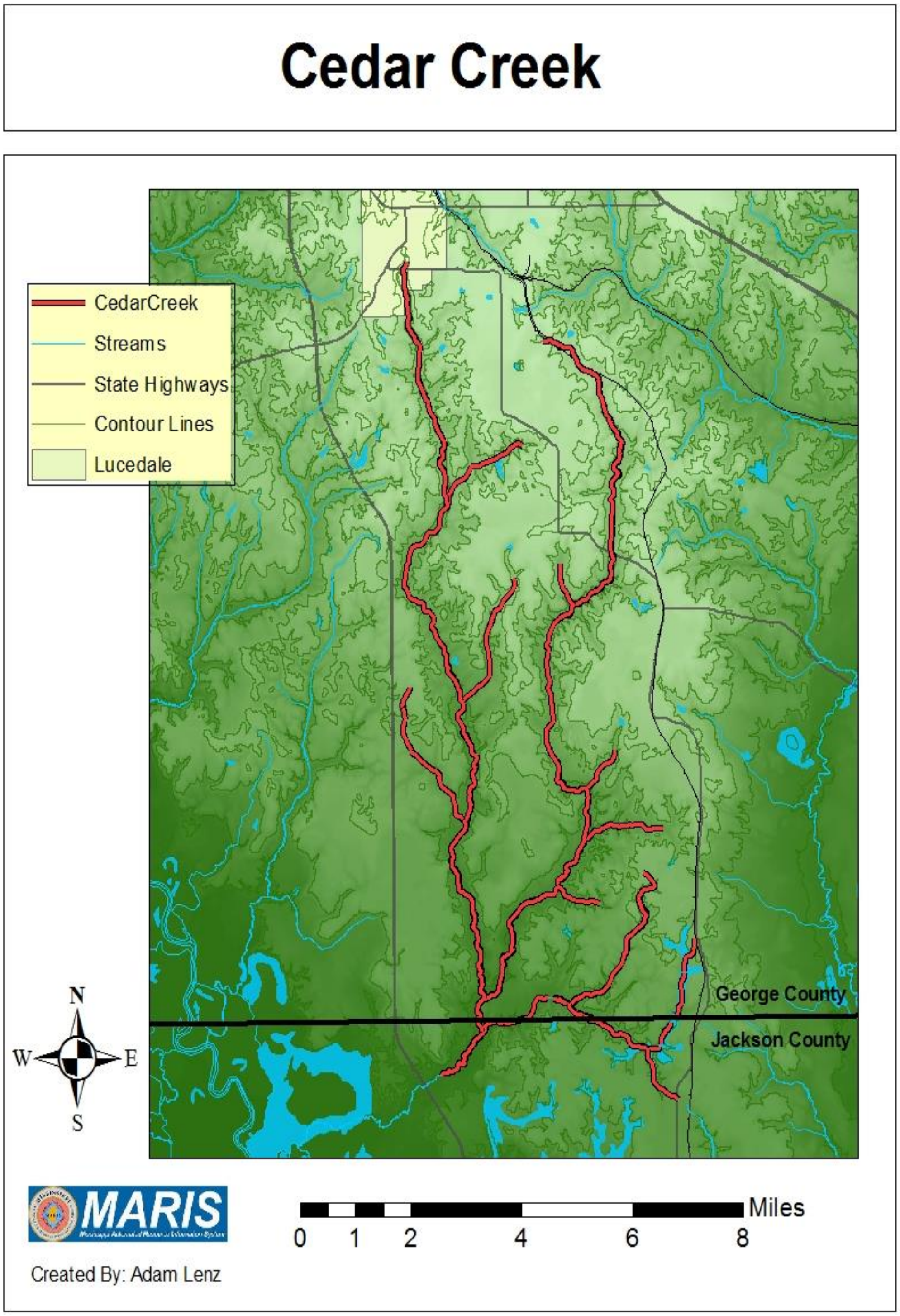

Figure 9 Cedar Creek Drainage Basin

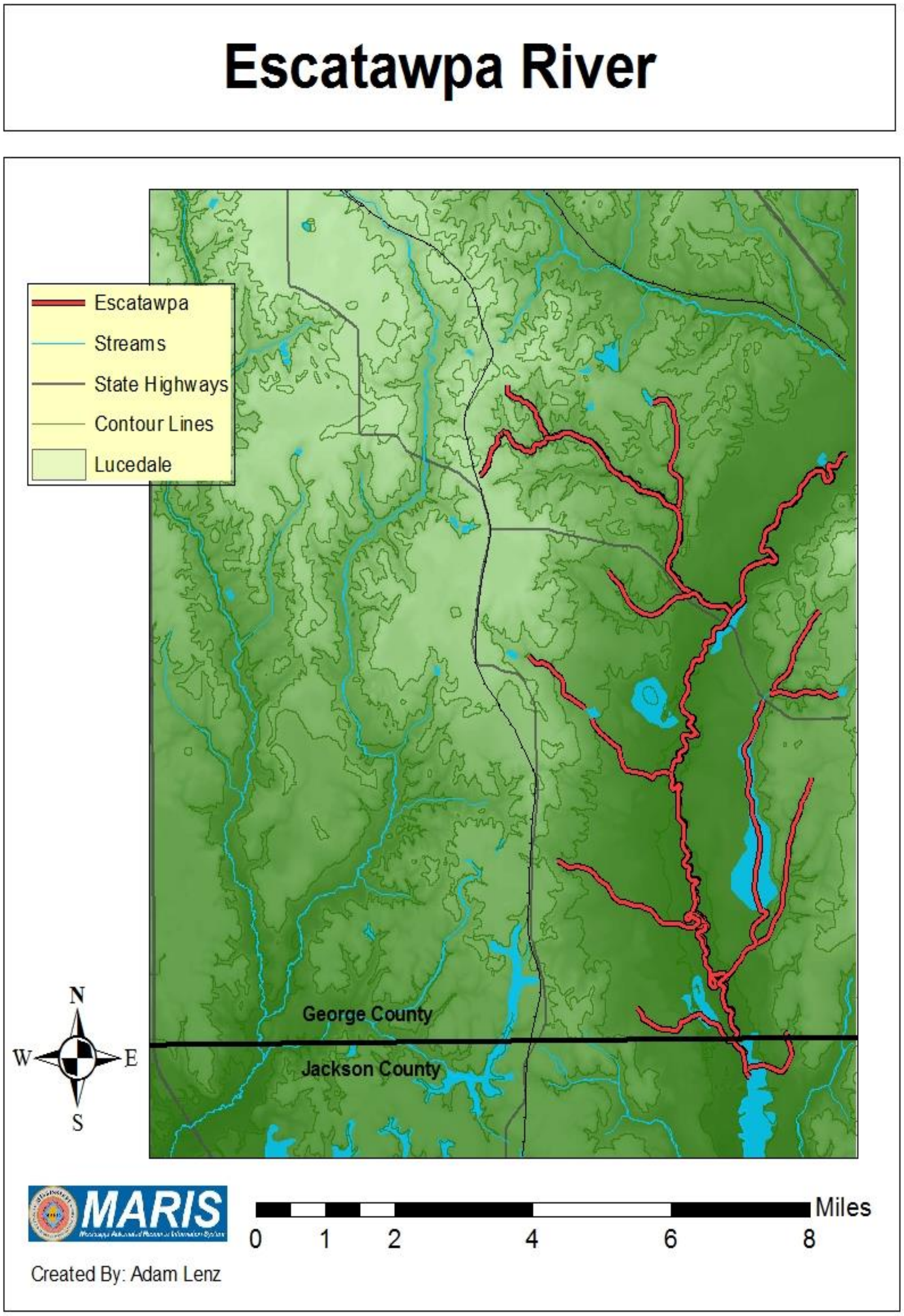

Figure 10 Escatawpa River Drainage Basin

Geologic Mapping

Geophysical logs and drillers' logs were obtained from the Mississippi Department of Environmental Quality (MDEQ) office in Jackson, Mississippi (See appendices for log examples). Logs were sorted based on the Mississippi State Plane Coordinate System and divided into township and range section numbers. Well logs were reviewed and filtered based on the following criteria; wells lie within the study area, wells have associated gps locations attached, and logs portray discriminate evidence of the subsurface geologic conditions. Geophysical logs, drillers' logs, and subsurface geologic data were also correlated to create detailed geologic maps and stratigraphic cross sections of potential reservoir locations.

Spring Inventory

A county-wide inventory of naturally flowing streams within the study area was conducted in order to help further characterize the geologic and hydro-geologic conditions of the shallow subsurface. Knowledge of spring locations gave insight into both the permeability conditions of the subsurface units, approximate dip angle and direction, and locations of our sand/clay contact zone. The spring inventory included spring location, elevation, flow conditions, and detailed notes incorporating surrounding geologic units, direction of flow, and structural geological features in the nearby vicinity. Data collected from the spring inventory was used in correlation with well log locations to help create stratigraphic cross sections.

Cross Sections

A literature review was conducted to help further characterize the basin geology and create stratigraphic cross sections during the correlation of the well logs. Primary literature descriptions of county wide geology came from Williams et al. (1967). Williams et al. (1967) describes the shallow subsurface geology as being composed of Citronelle formation followed by the underlying Pascagoula and Hattiesburg formations. The Citronelle formation is a Pleistocene age (1-3mya) terrace deposit composed of sand and gravel with intermittent clay lenses containing outcrops in thicknesses of no greater than 15 feet and only at higher elevations throughout the county. The much older Pascagoula and Hattiesburg formations are middle to late Miocene in age (15-20mya) and are described as clayey sands with small gravel lenses at depth. Formations are approximately 300 feet thick in the northeastern portion of the county, thickening to nearly 1000 feet in the southwest portion of George County. All of the shallow subsurface units were thought to be deposited during a long-term coastal regression with some short intermittent transgression phases.

CHAPTER VI

RESULTS

All research and field data were collected and compiled from June, 2011 to December, 2012. Cross Sections and maps were created using data collected from both Mississippi Department of Environmental Quality (MDEQ), Mississippi Department of Transportation (MDOT), and from Mississippi Automated Resource Information System (MARIS). This chapter is a collection of all results from the research and objectives outlined in Chapter V: Methodology as to determine the extent of a confining clay layer to be able to sustain a large reservoir in George County, Mississippi.

Geologic Mapping

A detailed surface geologic mapping of George County, Mississippi was conducted as a means for getting current to date, higher resolution maps than had been previously available. The last significant mapping project of George County geology was done by Williams et al. (1967). Surface maps of the study area were created by extracting surface elevations from 10-meter DEM (Digital Elevation Model) (MARIS, 2008) of selected townships in George County and Jackson County, MS (figure #11). 3-Dimensional maps of the topography of George County were created by extracting elevations from the DEM and importing them into a standard 3D surface mapping software (figure #12). All current to date water well logs and geophysical logs were retrieved from MDEQ and MDOT to characterize and delineate surface and subsurface geologic units.

Results from the mapping project have shown that as previously thought, there is a laterally extensive clay unit throughout the study area known as the Pascagoula/Hattiesburg formation that could potentially sustain a large reservoir. Well logs have shown that the uppermost Pascagoula/Hattiesburg formation consist of a clay unit approximately 60-100 feet thick in unweathered portions of the study area. The top of this lies at an elevation of 170feet above sea level in the north central region of the study area and dips south-southwest at approximately 12 feet/mile except in stream drainage basins throughout the study where streams have eroded all younger Miocene age deposits above the Pascagoula/Hattiesburg and cut into the thick clay layer. Results of the mapping project have indicated extensive erosion in the indicated drainage basins since the time of previous mapping project in 1967.

Results from the mapping project have shown that even in the highly eroded drainage basins the Pascagoula/Hattisburgh is still a significant clay layer that could potentially sustain a reservoir in all three of the selected drainage basins. The mapping project also showed no indication of significant faulting within the study area that would affect a potential reservoir itself or the lateral continuity of the Pascagoula/Hattiesburg clay layer.

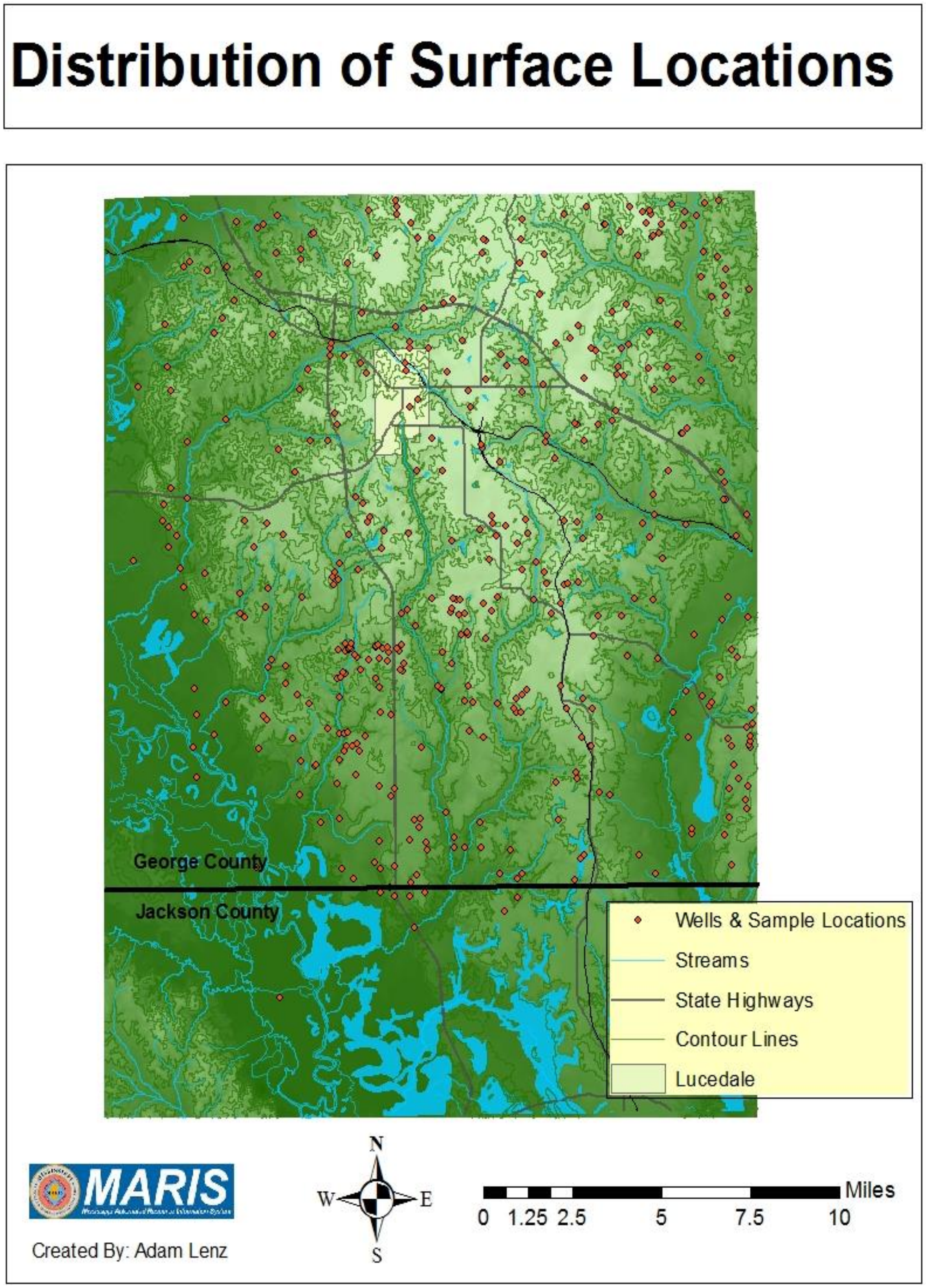

Figure 11 GPS Locations Used in 3D Mapping Project

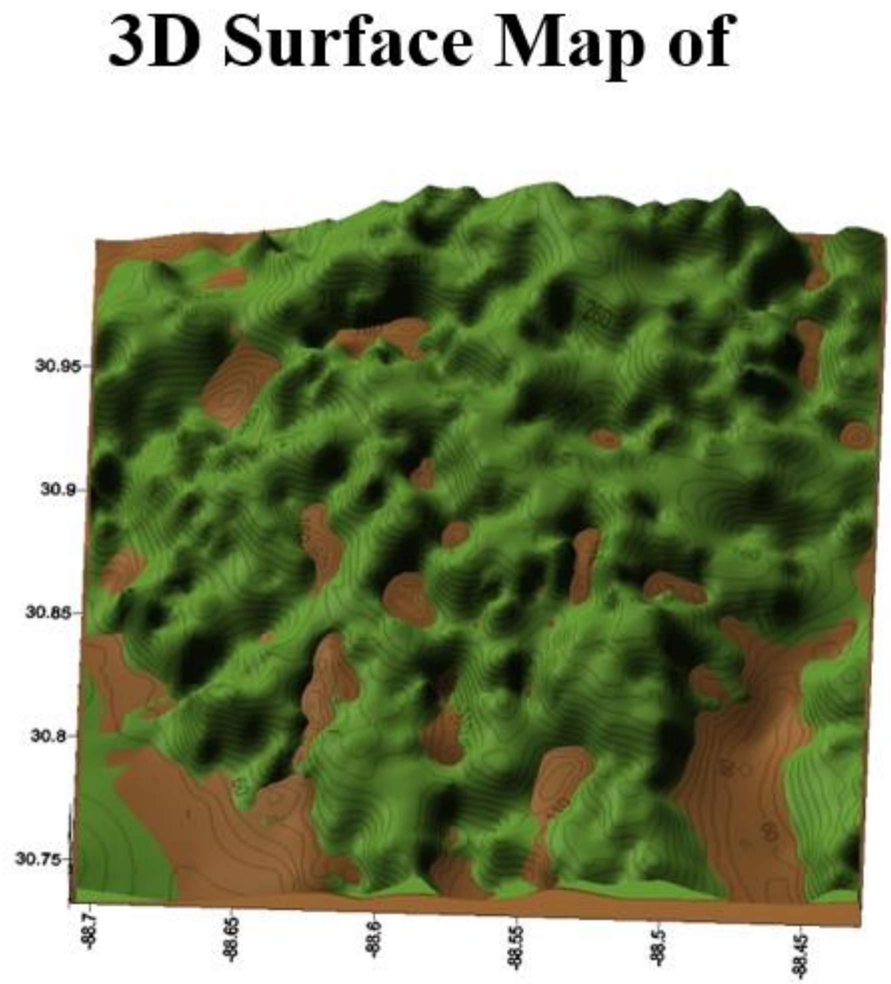

Figure 12 3D Surface Map of Study Area Showing Sand/Clay Contact Zone

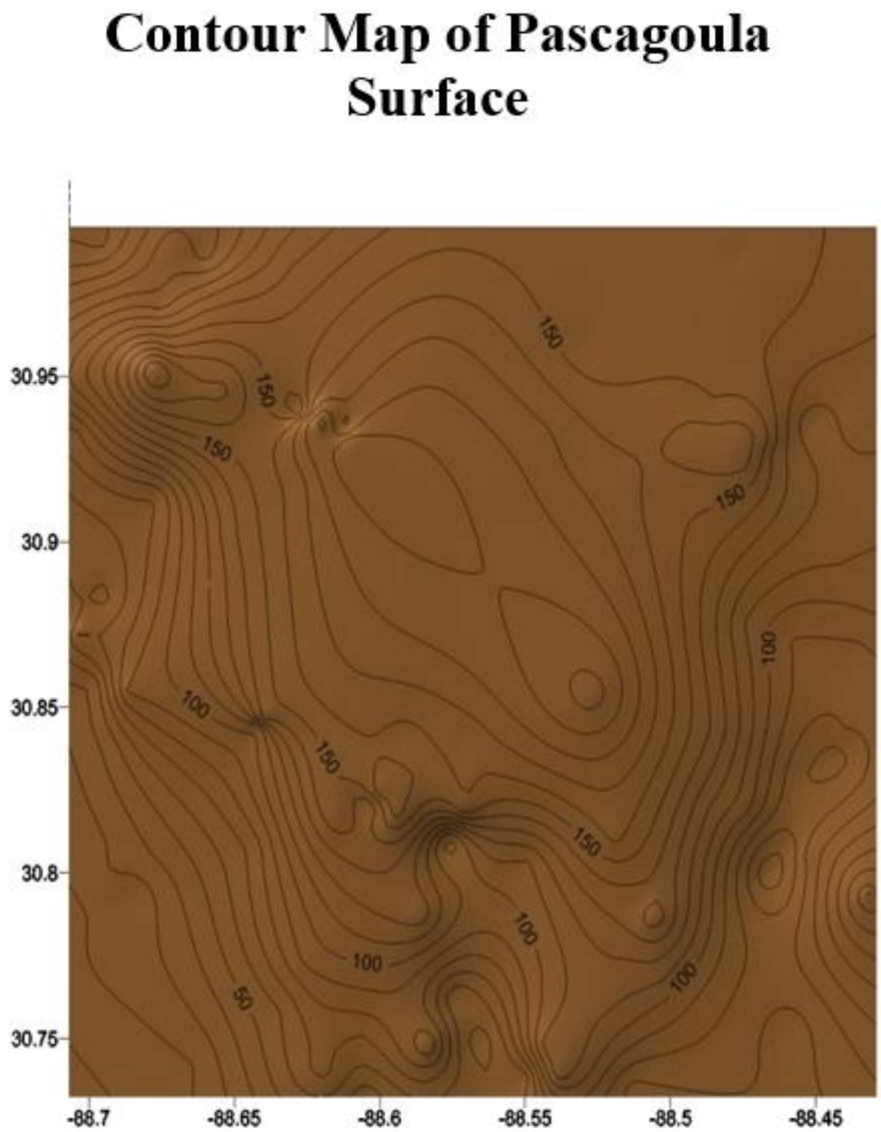

Figure 13 Contour Map of Pascagoula Formation Uppermost Clay Layer.

Spring Inventory

An inventory all spring locations within George County was conducted as a means for gaining information about the subsurface conditions and for getting an accurate determination of contact zones. All spring locations inventoried were found and collected on-site. Springs were found using previously mapped streams, first-hand knowledge from local residence, and knowledge of potential contact outcrops as stated in Chapter V: Methods. All inventoried spring locations were cross referenced with geologic maps created for the project as stated in the previous section.

Results from the spring inventory found 41 springs (table #1) within the study area that drain into the selected basins. Of those springs all were classified as small seeps at or just above the contact zone between the Citronelle and the Pascagoula/Hattiesburg formation. All springs had very low flow rates with discharges consistently >.1 cubic feet per second, and often immeasurable with standard field equipment such as the USGS AA current meter. Results also showed that none of the 41 springs were found to be anomalous in any way to indicate inconsistency within the lithology or conductivity values (figure #14). The spring locations, flow rates, and flow directions also show no indication of faulting that would affect a potential reservoir itself or the lateral continuity of the Pascagoula/Hattiesburg.

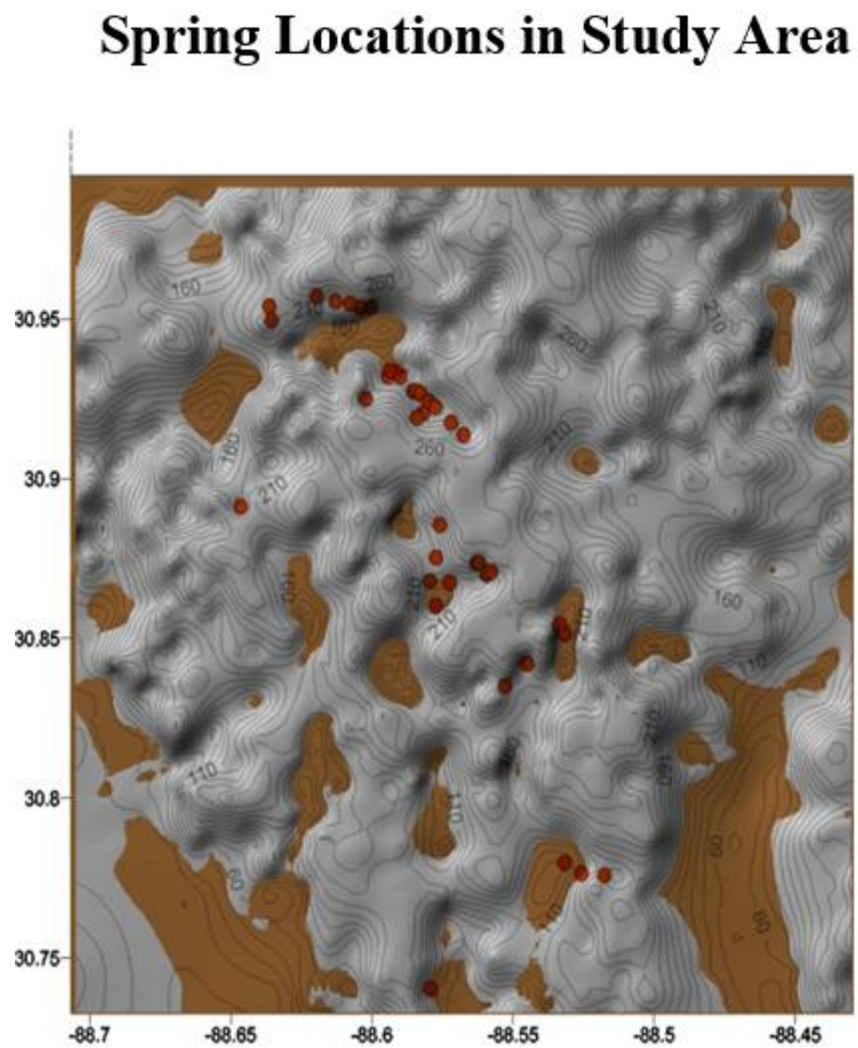

Figure 14 Spring Inventory Map of Study Area

Cross Sections

Cross sections were created across the width and down the length of each of the selected drainage basins in order to determine the extent and depth of the confining clay layer, and to find any inconsistencies among the lithology of the drainage basins. Williams et. al (1967) created the most recent cross sections of George County, however they are regionally defined over the entire county and are estimated from known data rather than using actual borehole data. All cross sections created for this study were done using recent well log data collected from MDEQ and MDOT with corresponding GPS locations.

Results from the cross section show that the Pascagoula/Hattiesburg is a thick, laterally extensive clay layer that is seen in the subsurface throughout the entire study area. Results from the cross sections confirm our geologic surface mapping results, that the Pascagoula/Hattiesburg is >100 feet thick in the north central sections of the study area and reduce to a thickness as low as 30 feet thick in many of the stream drainage basin where sediments have been highly eroded. Cross sections also show at thin layer of stream alluvium (<10 feet thick) in some wells located within close proximity of the stream bed. When present in cross sections, stream alluvium is deposited as a surficial sedimentary deposit lying on top of both the Pascagoula and Citronelle, or on top of just the Pascagoula when all Citronelle has been eroded out of the stream drainage basin.

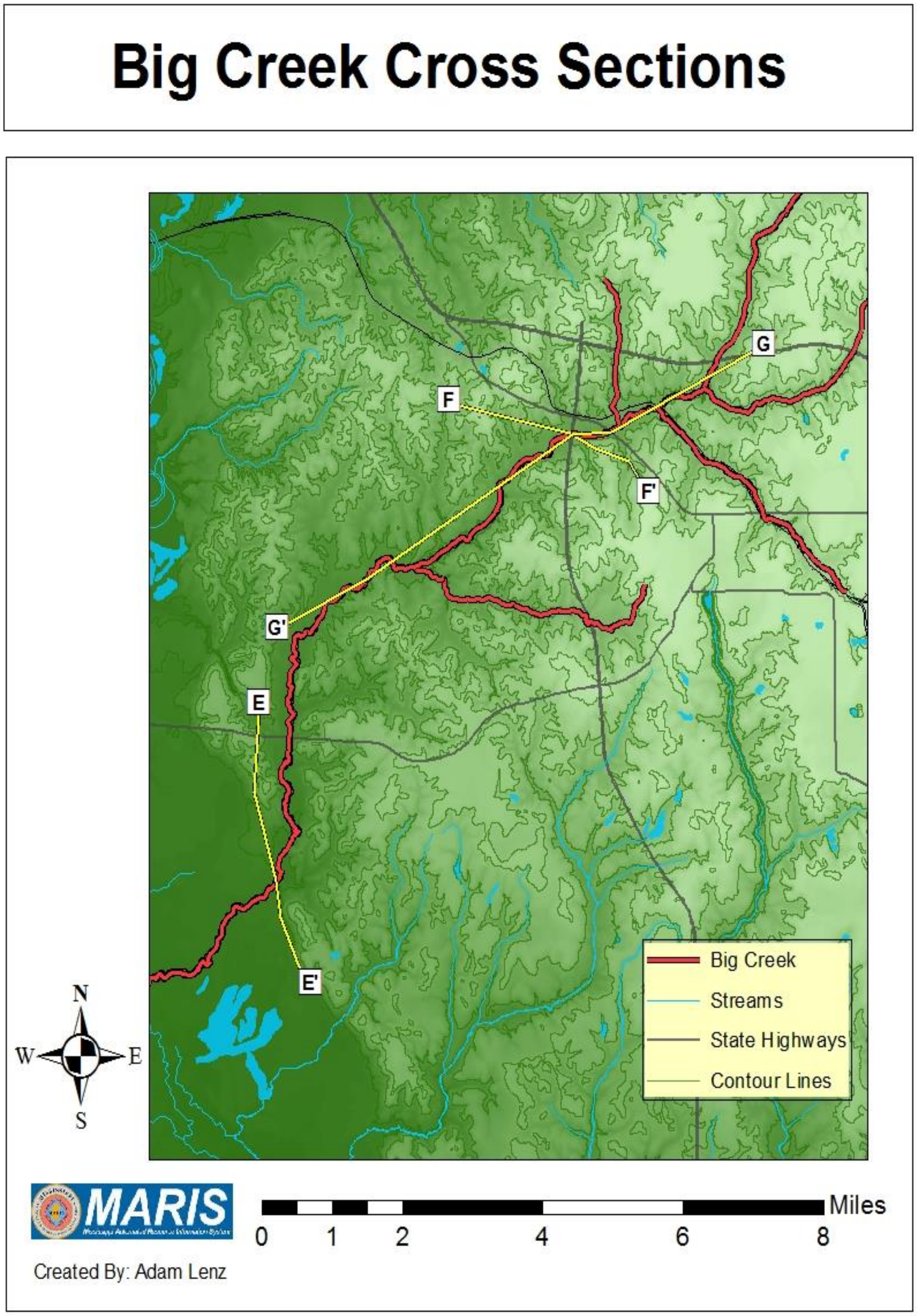

Figure 15 Cross Section Locations on Big Creek

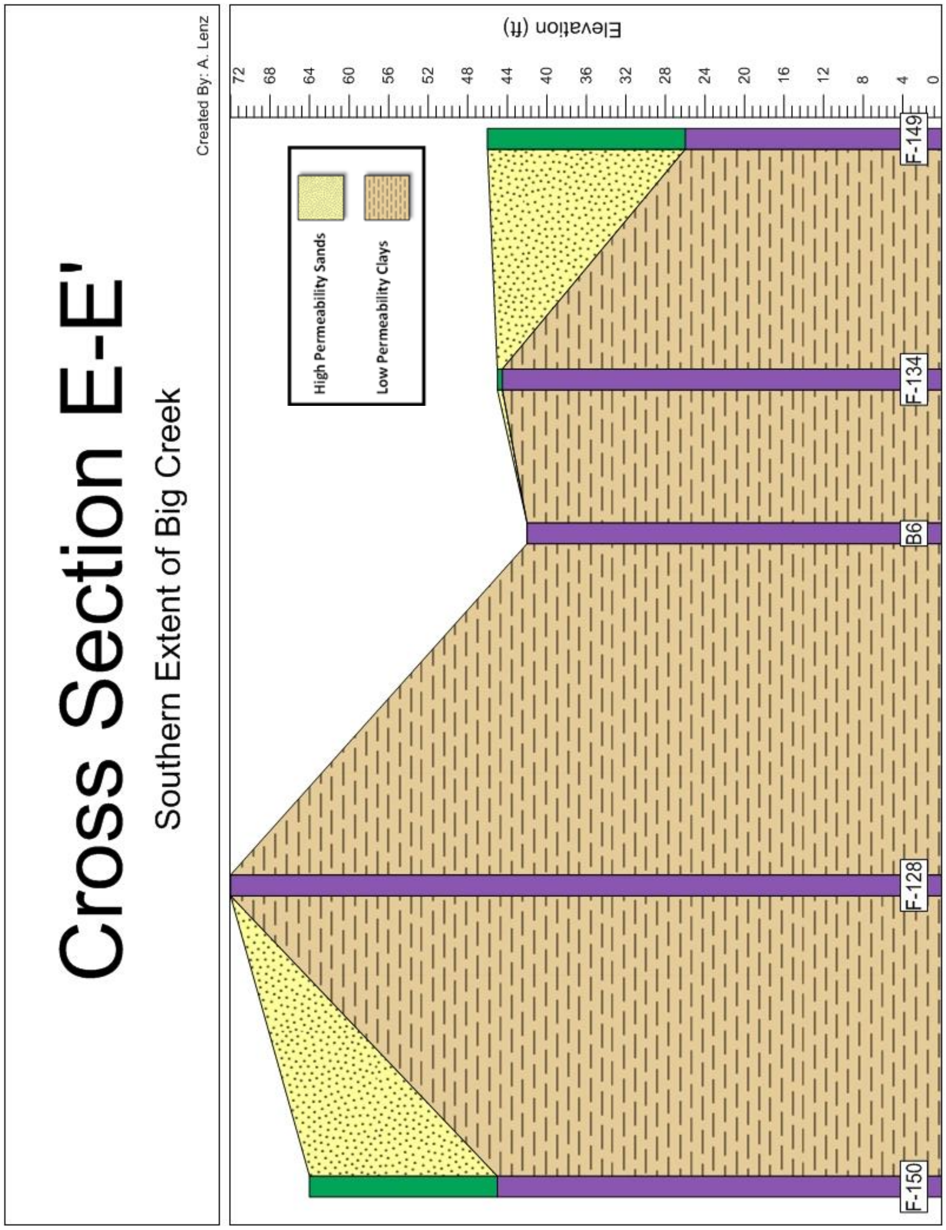

Figure 16 Cross Section E-E’ on Big Creek

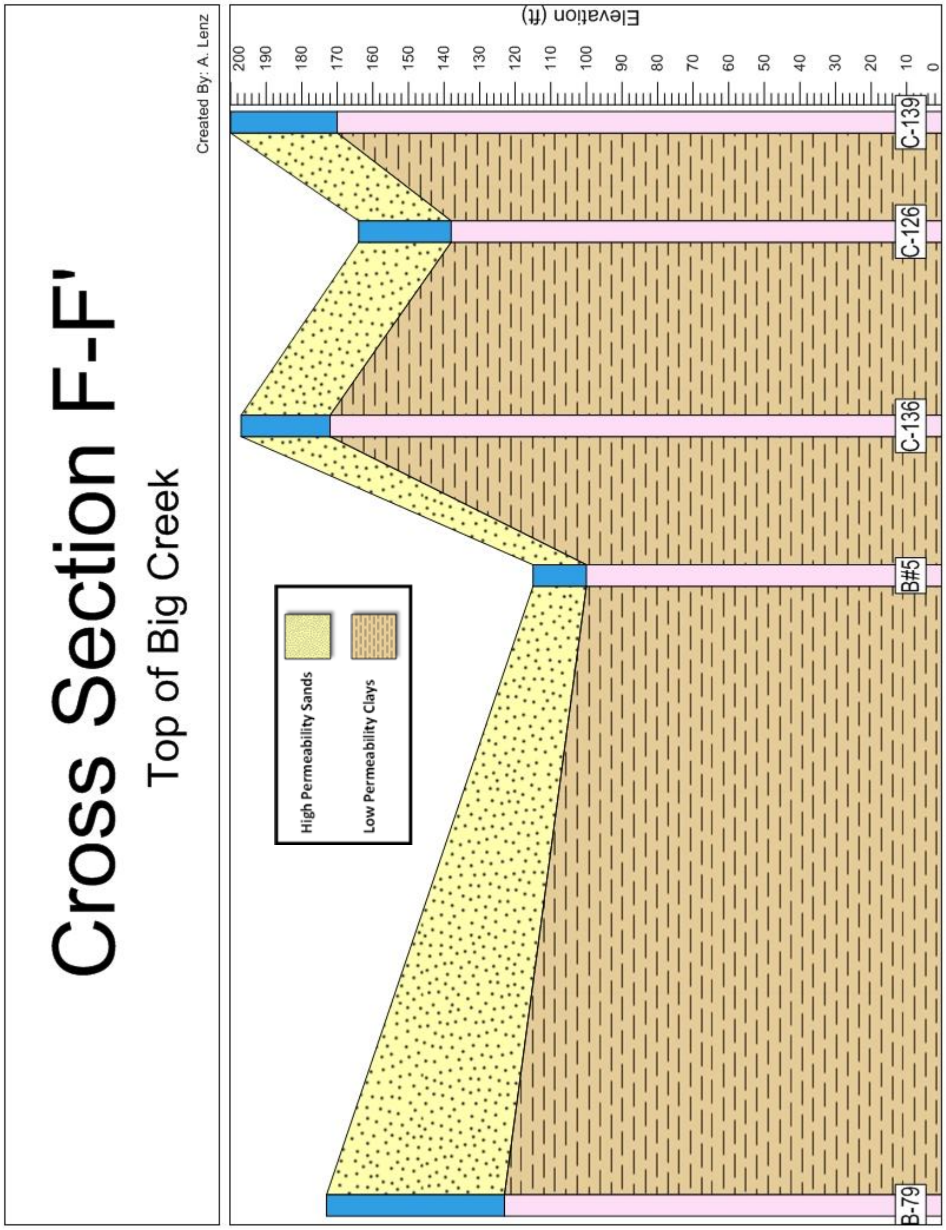

Figure 17 Cross Section F-F’ on Big Creek

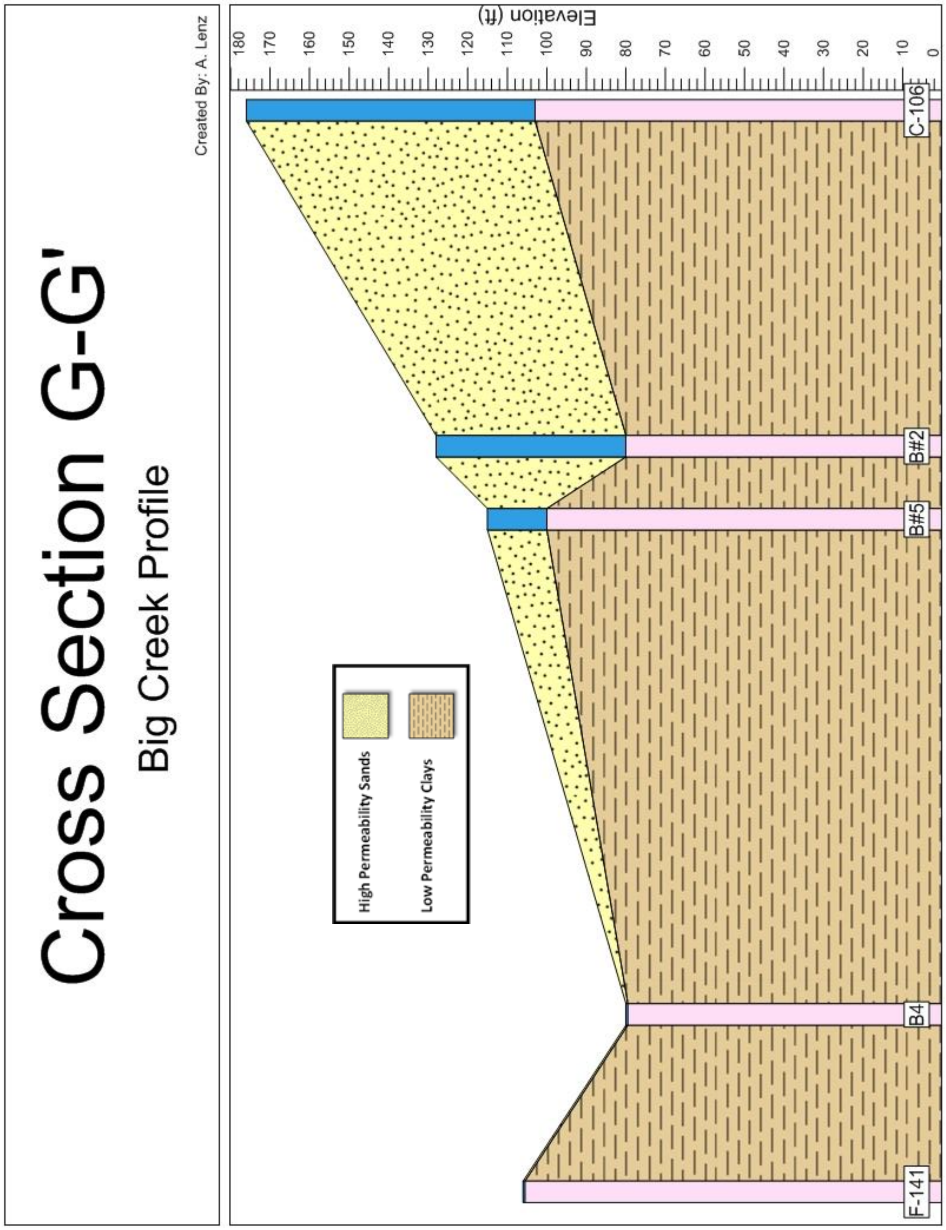

Figure 18 Cross Section G-G’ on Big Creek

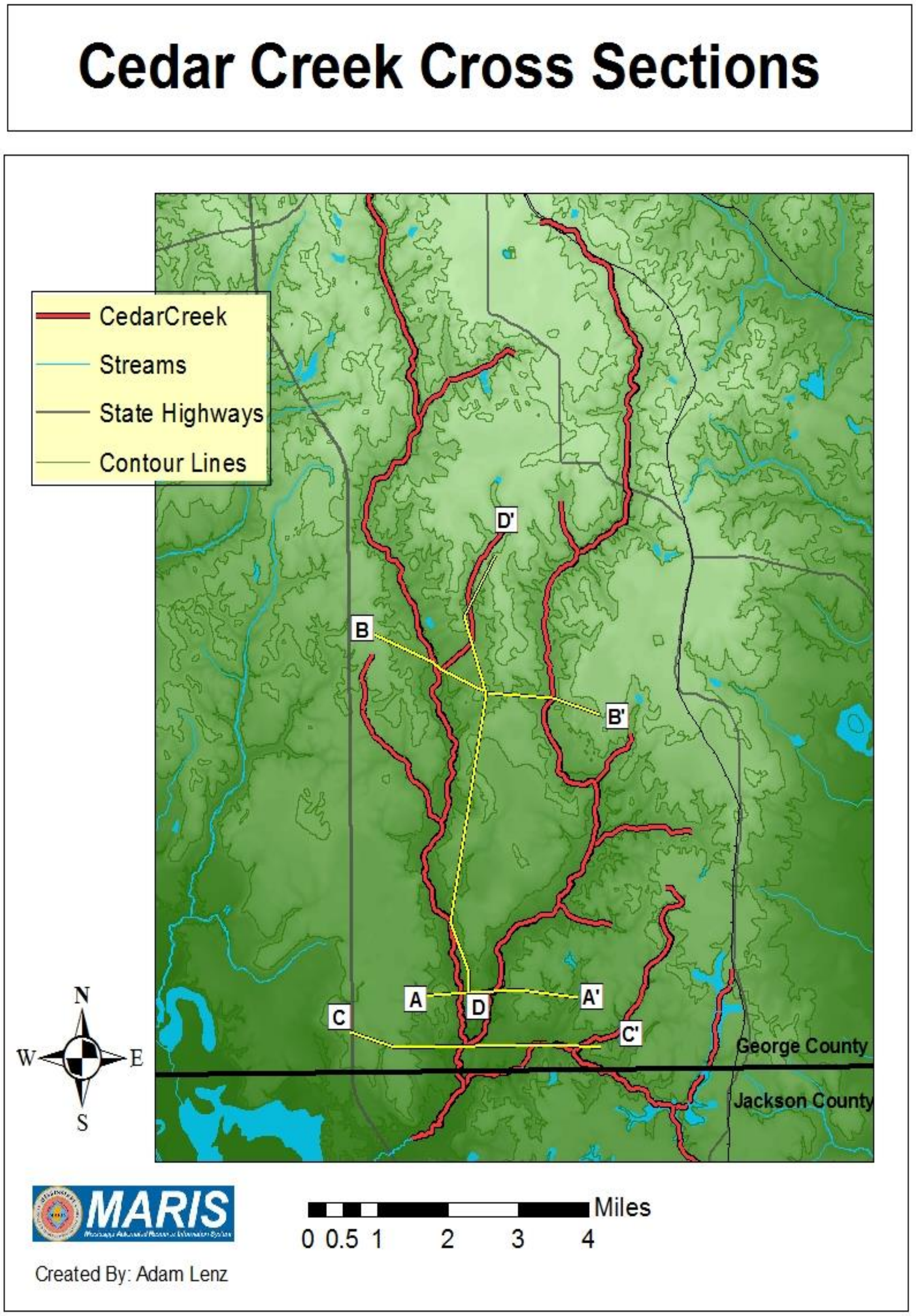

Figure 19 Cross Section Locations on Big Creek

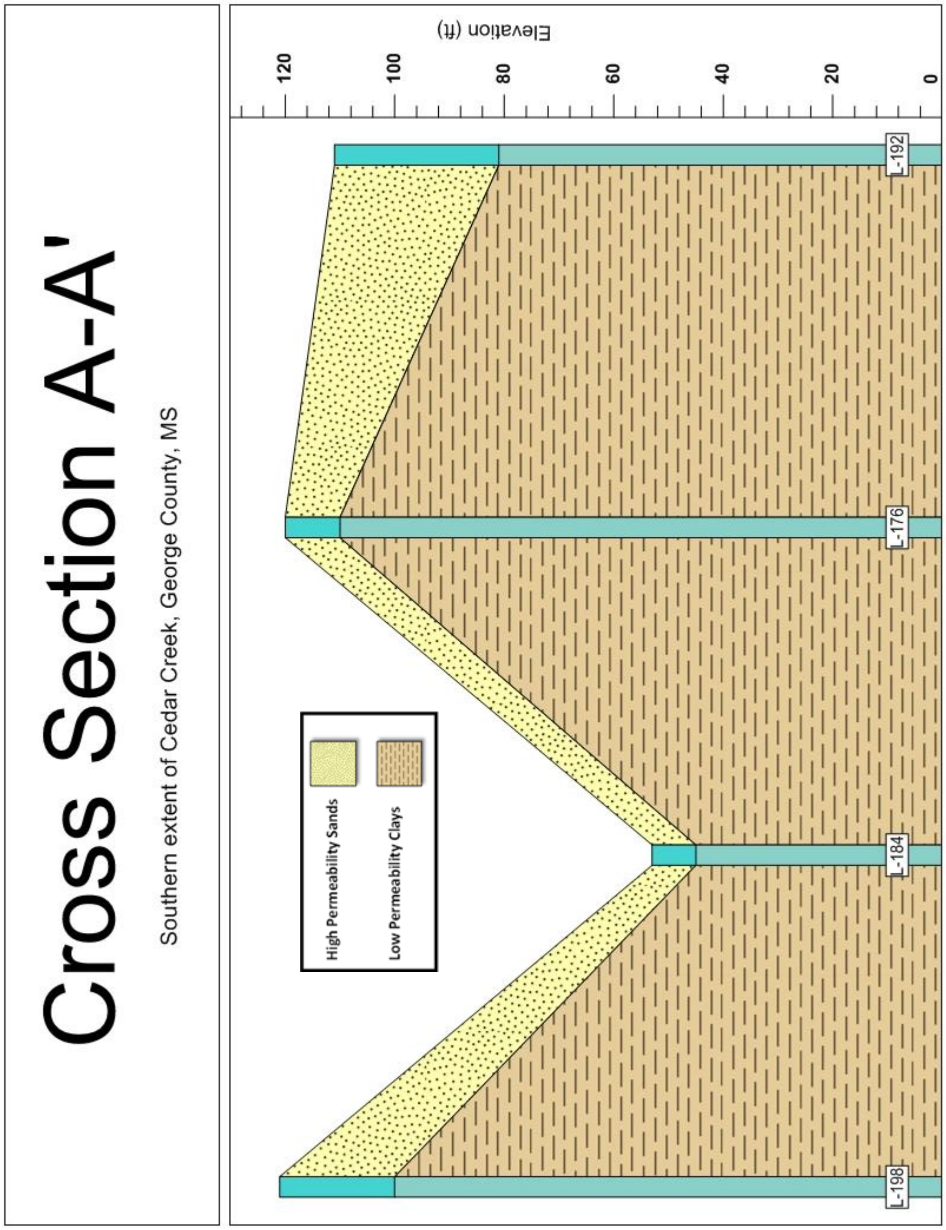

Figure 20 Cross Section A-A’ on Cedar Creek

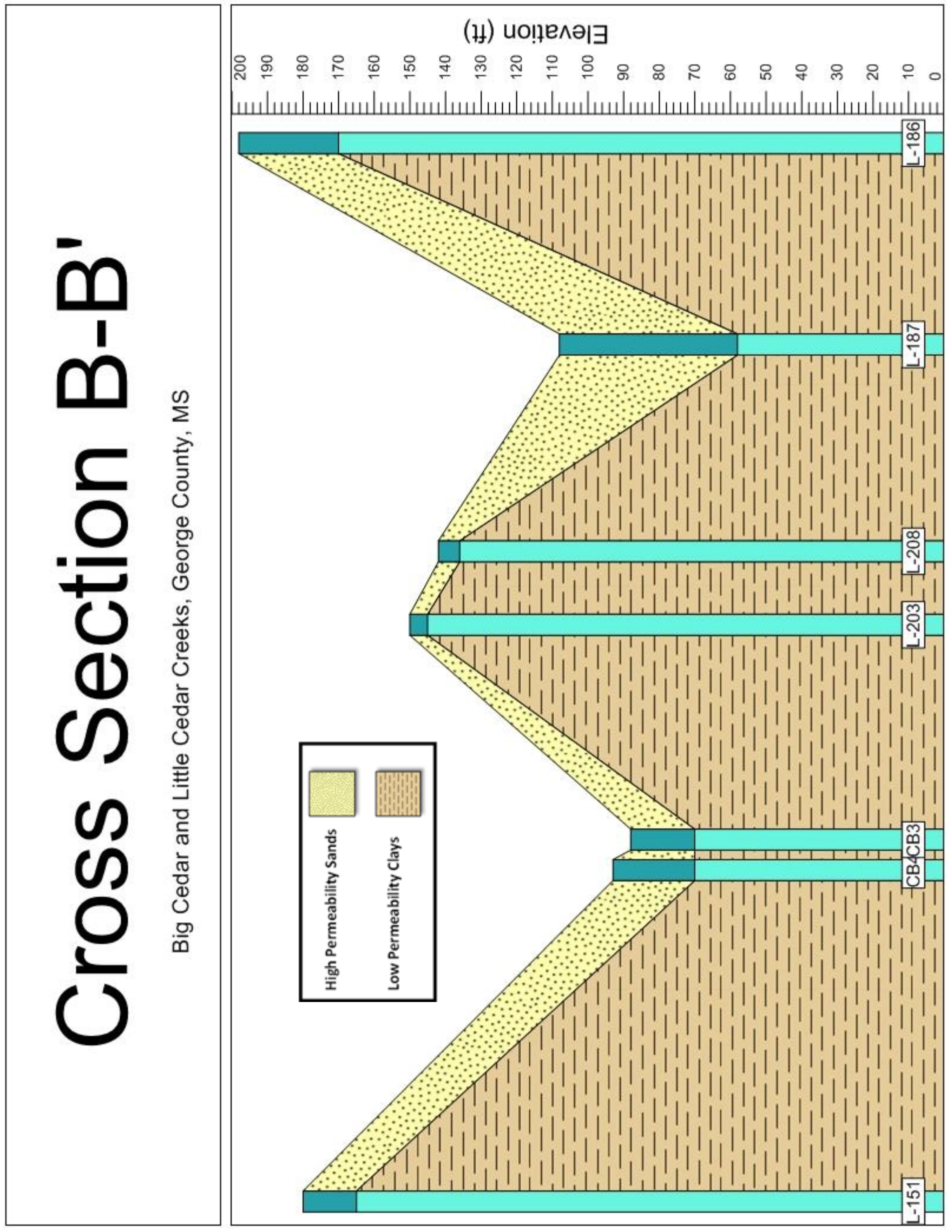

Figure 21 Cross Section B-B' on Cedar Creek

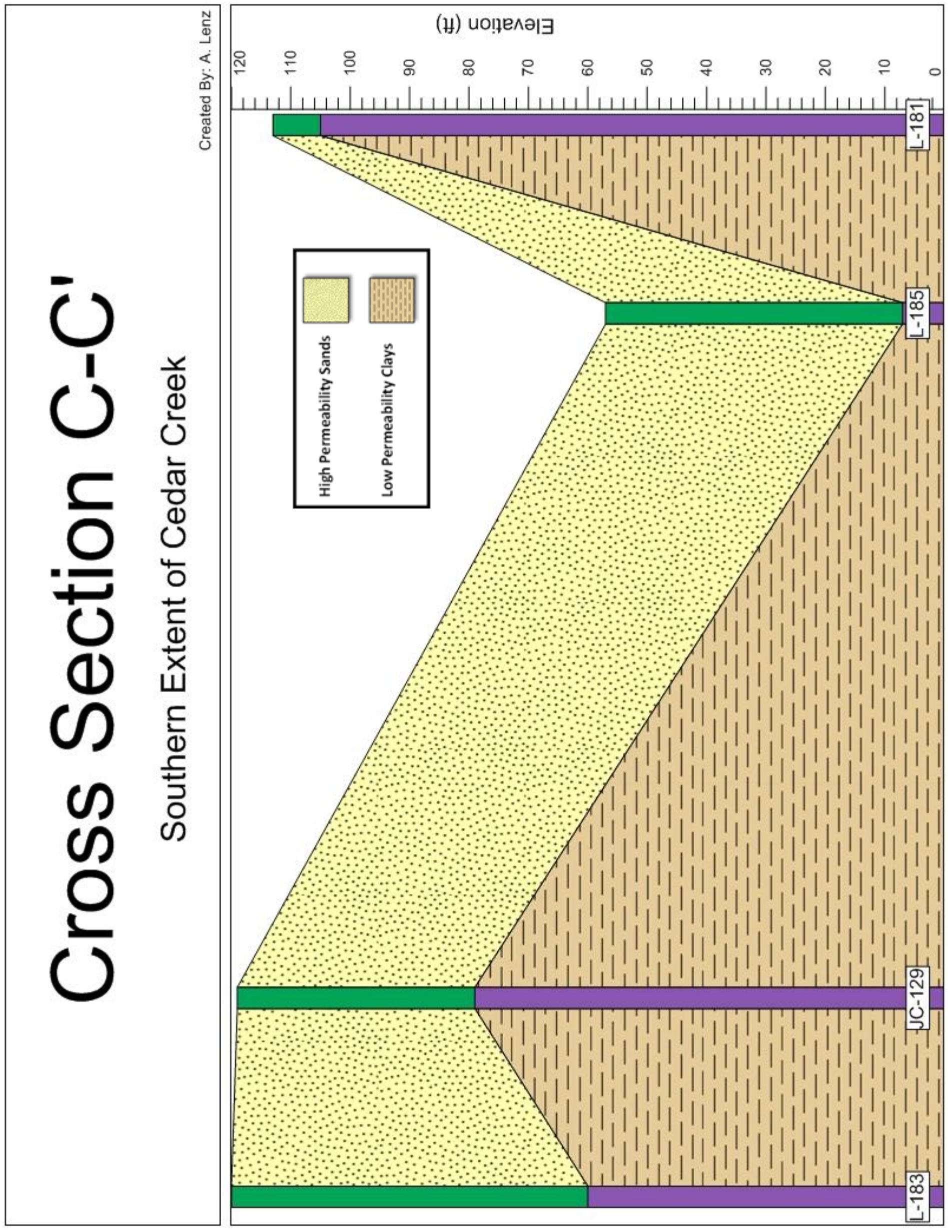

Figure 22 Cross Section C-C’ on Cedar Creek

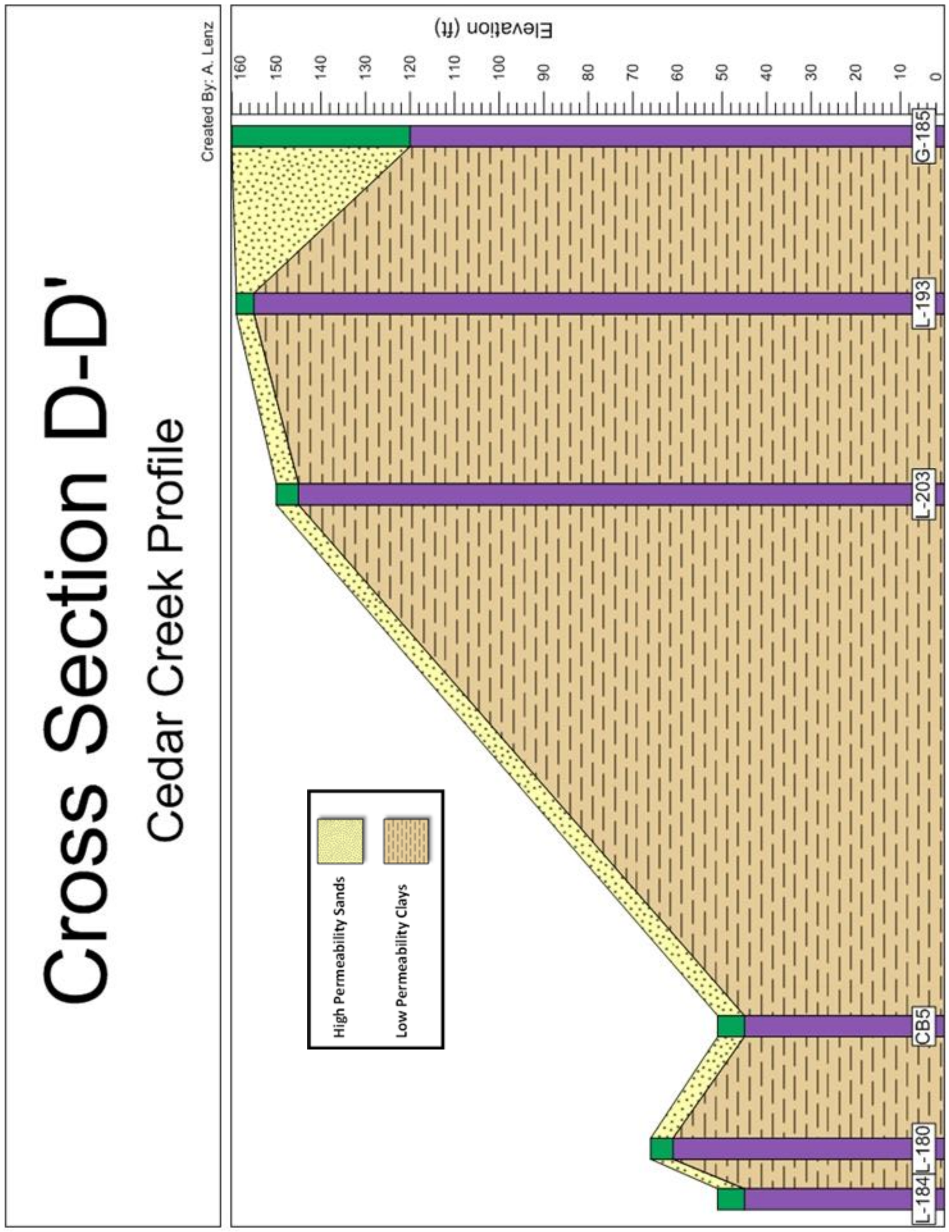

Figure 23 Cross Section D-D’ on Cedar Creek

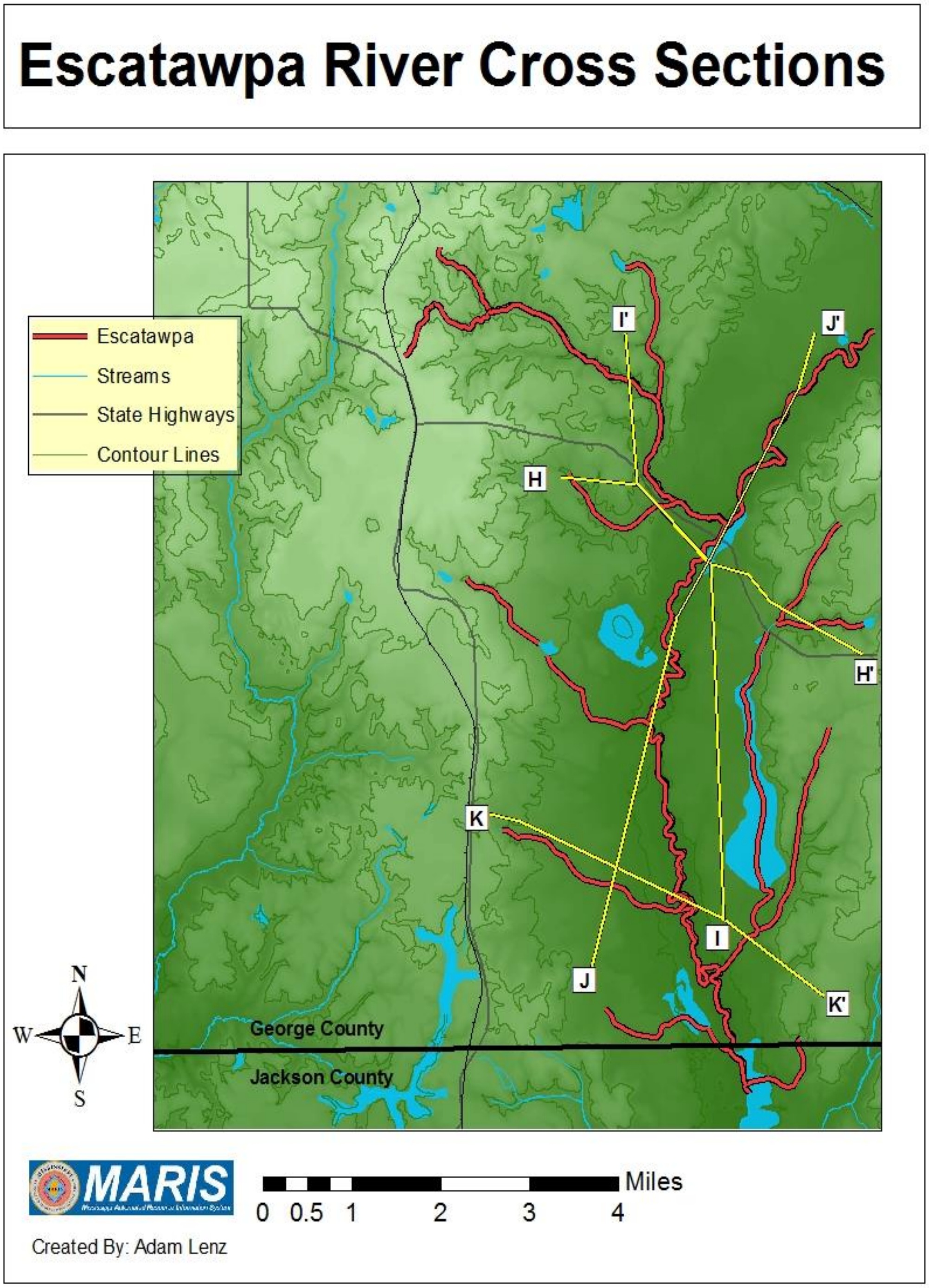

Figure 24 Cross Section Locations on Escatawpa River

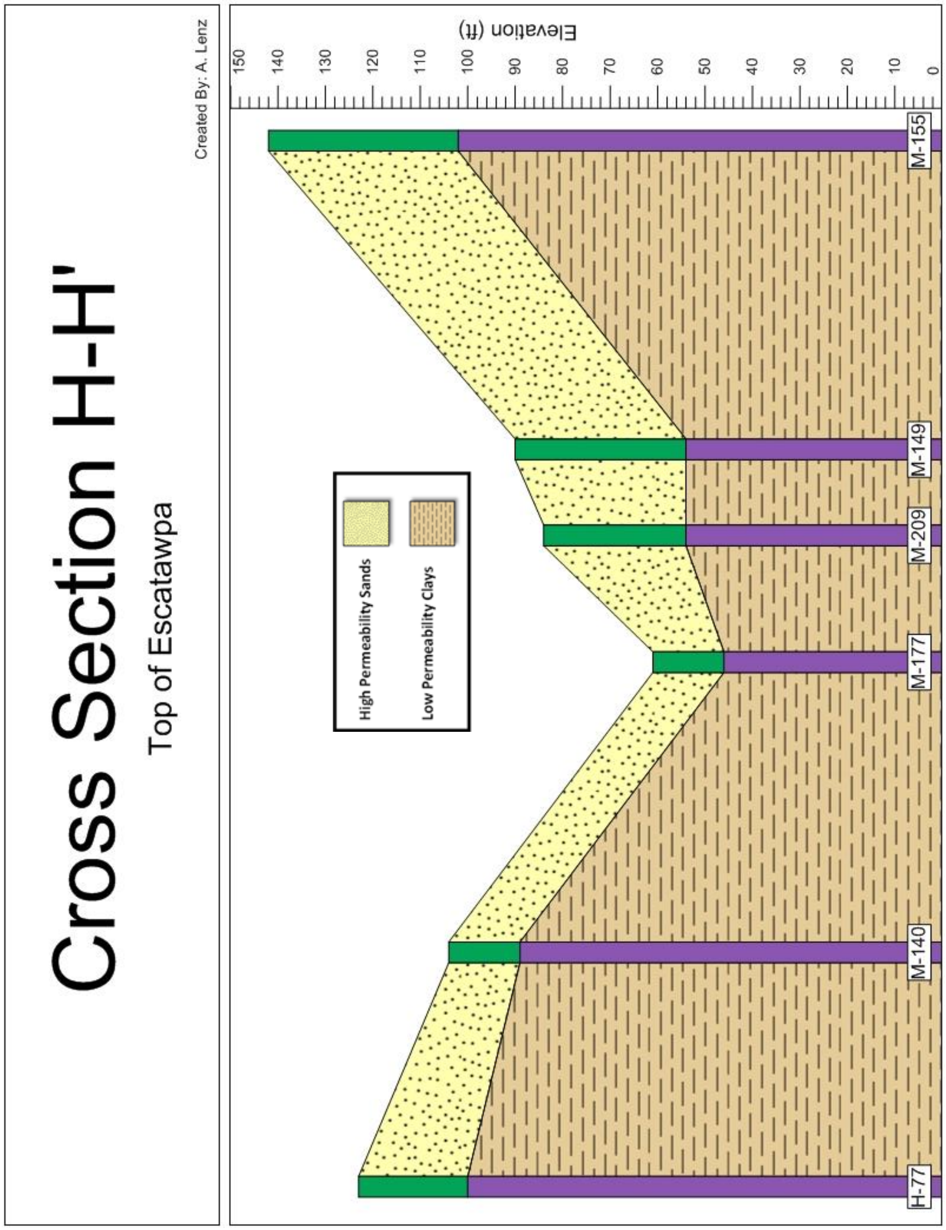

Figure 25 Cross Section H-H’ on Escatawpa River

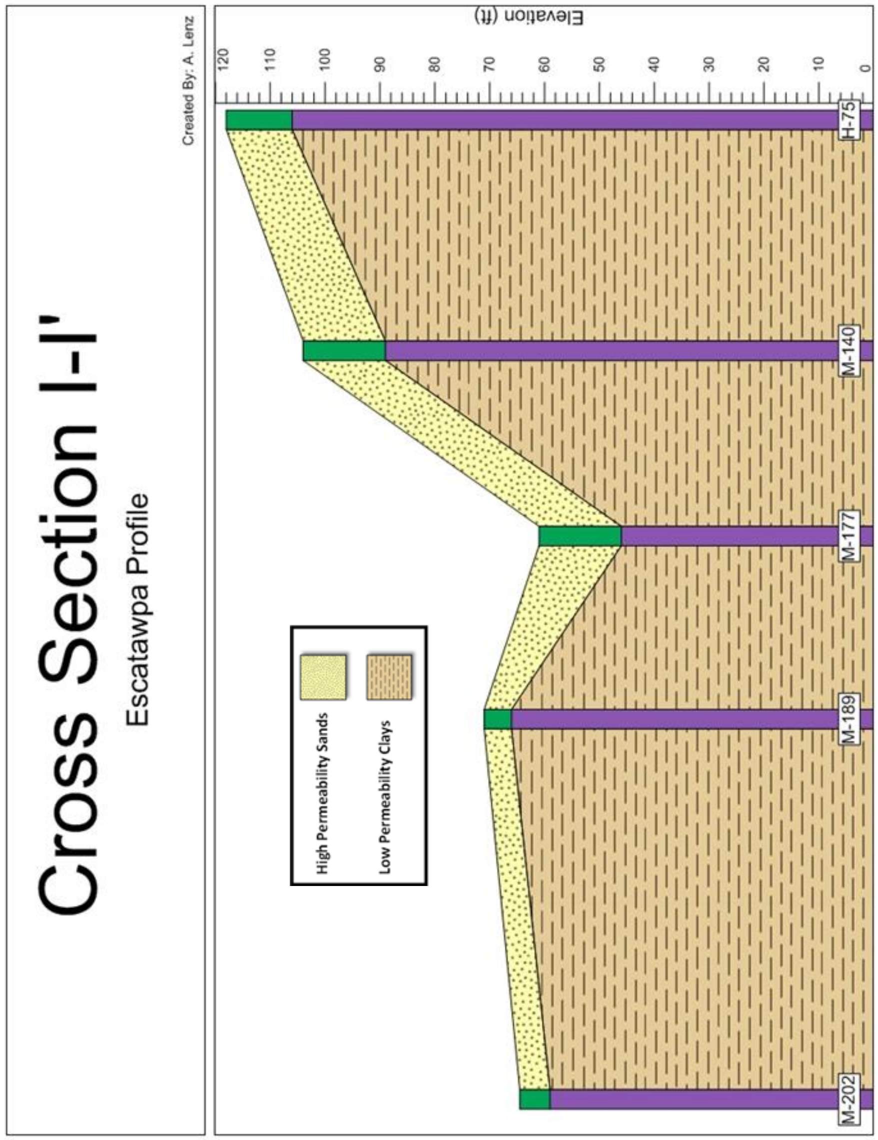

Figure 26 Cross Section I-I' on Escatawpa River

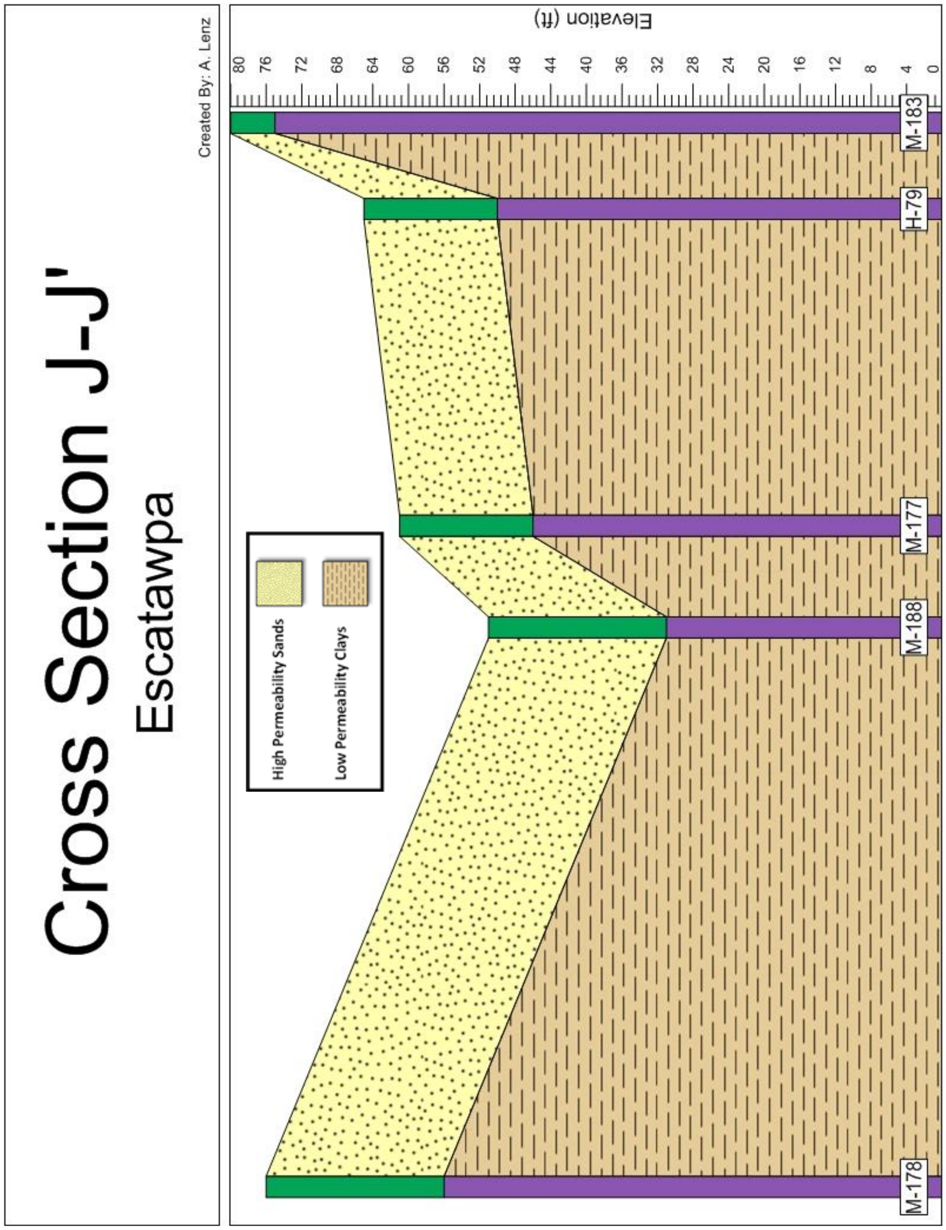

Figure 27 Cross Section J-J' on Escatawpa River

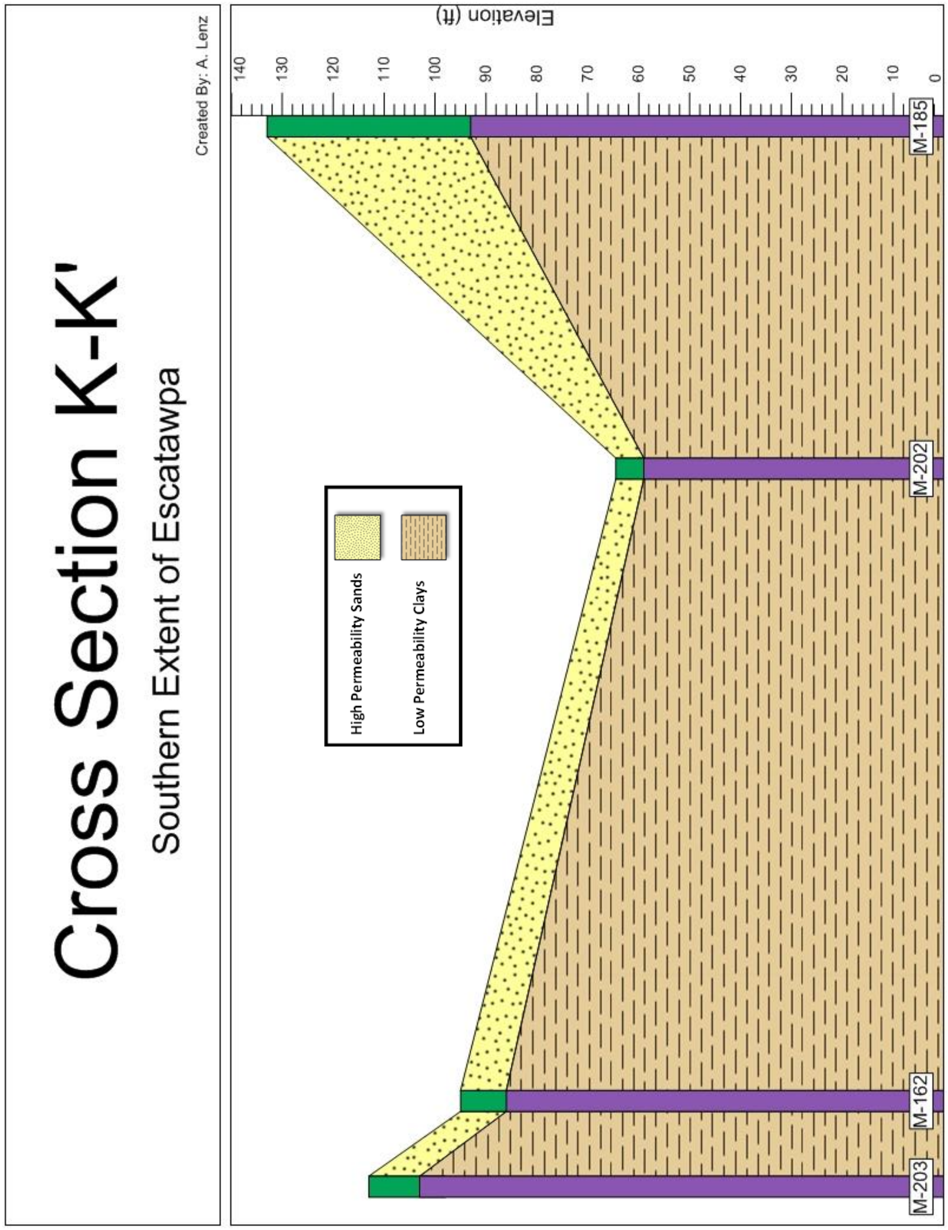

Figure 28 Cross Section K-K’ on Escatawpa River

CHAPTER VII

DISCUSSION

Geologic Mapping

As stated in previous sections, a geologic mapping project was done in order to determine the thickness and lateral extent of subsurface geologic units in order to make a determination about each basins potential for sustaining a large reservoir. In order to make that determination this study was directed at looking for clay layer at the top of the Pascagoula Formation which could serve as a confining layer for a proposed reservoir in George County, Mississippi. During the mapping project this study was conducted by looking for the contact zone between the uppermost clay layer from a fining upward sequence at the top of the Pascagoula Formation and an overlying high permeability sand layer composed of previously mapped Citronelle as well as any stream alluvium or highly weathered re-deposited material.

All geologic mapping data included only those well logs with known locations and/or attached gps locations to achieve the greatest level of accuracy possible. In doing so this decreased the resolution potential for our geologic maps from a possible >2,500 data points to 454 data points over our 324 square mile study area. Although the decreased resolution was not ideal, it was an anticipated result of highlighting the known surface and subsurface data.

Furthermore, only well logs containing evidence of the distinctive sand-clay contact zone known as the Citronelle-Pascagoula contact zone were used to create the geologic mapping project. It should be noted that when interpreting well descriptions there is not always a distinct difference between the Citronelle formation and stream alluvium unless the driller named each unit in his log descriptions. This was an unfortunate and un-anticipated result of the mapping project. However, the uppermost Pascagoula formation clay layer would be the confining layer for any potential reservoir and that the Citronelle and stream alluvium have predominately the same basic hydrogeological properties as compared to that of the Pascagoula clays, the overlying non-descript high permeability sands does not pose a threat to the feasibility and effectiveness of a potential reservoir. In conclusion it should be noted that the sand-clay contact zone may not be limited to the previously described Citronelle sands. Similar issues were evidently seen in previous mapping project by Williams et al (1967) where he mapped the "base of the Citronelle Formation" in which to show the contact zone.

Spring Inventory

As stated in previous sections, an inventory of all spring locations within George County was conducted as a means for gaining information about the subsurface conditions and for getting an accurate determination of the contact zones of the sand-clay contact within the study area. After a review of the spring inventory and spring inventory map it was determined that there were no anomalous results found in the spring inventory study, and therefore supported results from the sand-clay contact zone mapped during the geologic mapping portion of this study.

It should be noted that the methods for determining spring locations was conducted in the much the same manner as done in previous studies such as; McMillin (2007) and McIlwain (2007). As anticipated, all spring locations recorded in the study area were classified as very low discharge seeps near the sand-clay contact zone. A high majority of the springs found were in at the headings of small tributary streams discharging into Big Creek and Big Cedar Creek in the north central region of the study area. Due to the results it is concluded that it is preferential for these seeps to occur in areas near the sand-clay contact zone, but also where there is substantially thickness of Citronelle overlying the contact zone which predominantly occurs in the north central part of the of the study area where substantially less weathering has occurred. This study only recorded springs that flow directly into the selected drainage basins and therefor may not include all areas in the shown in Figure #7 such as the parts of the north-eastern and south-western corners.

Cross Sections

Cross sections were created across the width and down the length of each of the selected drainage basins in order to determine the extent and depth of the confining clay layer, and to find any inconsistencies among the lithology of the drainage basins. Locations of wells used for creating cross sections of each basin were determined based on both wells with distinctive sand-clay contact zones and wells that would highlight those areas most likely to be potential reservoir locations. The creation of selected cross sections was completed from known subsurface data found in used wells logs. Cross sections consistently distinguish between sediments known to be of the Citronelle Formation versus that of stream alluvium much in the way that it wasn't distinguished in the geologic mapping project. In geophysical logs, and in previous studies of George County, stream alluvium is seen consistently seen at the surface directly adjacent to the stream with a thickness of <15 feet. It is speculated that this stream alluvium is present in the lower portions of all three selected drainage basins; however stream alluvium was only designated as such in the cross sections if it was known based on current subsurface data. Again, we believe that this study achieved accurate portrayal of the sand-clay contact zone and therefor in each cross section even if particular well logs do not distinguish between Citronelle and stream alluvium.

It should also be noted that cross sections do not depict scale depths or thickness of the Pascagoula clay layer. As stated in Chapter VI the uppermost Pascagoula clay layer is seen in well logs at depths of >100 feet in regions of the study area, but all cross sections were cut off at a an elevation of zero feet sea level to highlight particular features such as topography, the sand-clay contact zone, and any potential seismic activity in the subsurface.

Among the selected cross sections, there are a few wells that appear to portray anomalous geologic conditions including potential faulting, non-uniform thickness of sediments, and possible missing units. It should be noted that wells and cross sections appearing to be anomalous are actually normal subsurface conditions anomalous in cross sections because of the location of the well relative to the major river within the selected drainage basin and the smaller tributary streams, the specific type of sediment, and the scale of the cross section.

Big Creek cross section E-E' (Figure #16) shows what appears to be a potential fault or up-thrown block of low permeability sediment, however this feature is actually two separately deposited high permeability sands. The sands seen in cross section are deposited as Citronelle or High Terrace deposits while the wells in the in the Southeast are in the Pascagoula River floodplain and are characterized as the much younger stream alluvium sands. Big Creek lies at the surface between these high permeability sands and has eroded everything down to the lower permeability clay layer.

Cedar Creek cross section D-D' (Figure #23) illustrates the profile of the stream from North to South shows a distinctly thick layer of high permeability sands in the northern most well G-185. This thicker section of sand appears to be anomalous; however (Figure #19) shows that well G-185 lays outside of the stream drainage basin where the high permeability sands have not been subjected to the same weathering and erosional processes as the more southern wells seen in the same cross section. Well L-180 in the same cross section appears rise in elevation creating the appearance of an unnatural dipping angle.

Cross section map (Figure #19) shows that this well is not in the predominate stream basin, but in an in a smaller tributary stream that that enters Cedar Creek near the southern extent of the drainage basin.

Cedar Creek cross section C-C' (Figure #24) appears to be anomalous as compared to any other cross sections on Cedar Creek giving the appearance of higher relief topography and unnaturally thinning sand beds. However, figure #19 shows the cross section runs perpendicularly across the main stream channel, but along a tributary stream. The placement of the cross section illustrates part of a stream profile in the wells ling to the east with thin sand beds in the east, while the other wells laying west of the floodplain of Cedar Creek with thicker unweathered sand beds at the surface.

CHAPTER VIII

CONCLUSION

After an extensive study of potential reservoir locations of selected drainage basins of George County, Mississippi based on geologic suitability for holding and sustaining a large reservoir it is concluded that there is a laterally extensive clay layer seen throughout the study area in the shallow subsurface deposited at the top of a fining upward sequence that is thought to be have the geologic potential to sustain a large reservoir. Through a surface mapping project, spring inventory, and well log correlation of cross sections it was determined that this clay layer is laterally extensive and seen in all three selected drainage basins, is relatively thick and dominates the shallow subsurface, and shows no evidence of apparent faulting. It should be noted that clays deposited in shallow marine environments such as the clay layer of interest, are known to be discontinuous over large regions with variable thicknesses due to the nature of their depositional processes.

It is concluded through methodology used in this study that no single preferential drainage basin is present based solely on geologic suitability for holding and sustaining a large reservoir in George County, Mississippi. All three drainage basins have well logs that show the reasonably thick uppermost Pascagoula clay layer in the subsurface with an overlying high permeability sand, previously mapped as the Citronelle Formation, which thins in the highly eroded lower portions of each drainage basin.

It is recommended that as further research is conducted selective drilling of dam locations to confirm the exact elevations of the sand-clay contact zone in the subsurface and permeability tests of both the clays and sands to get a much better assessment of the potential for long term sustainability of a large reservoir should be included.

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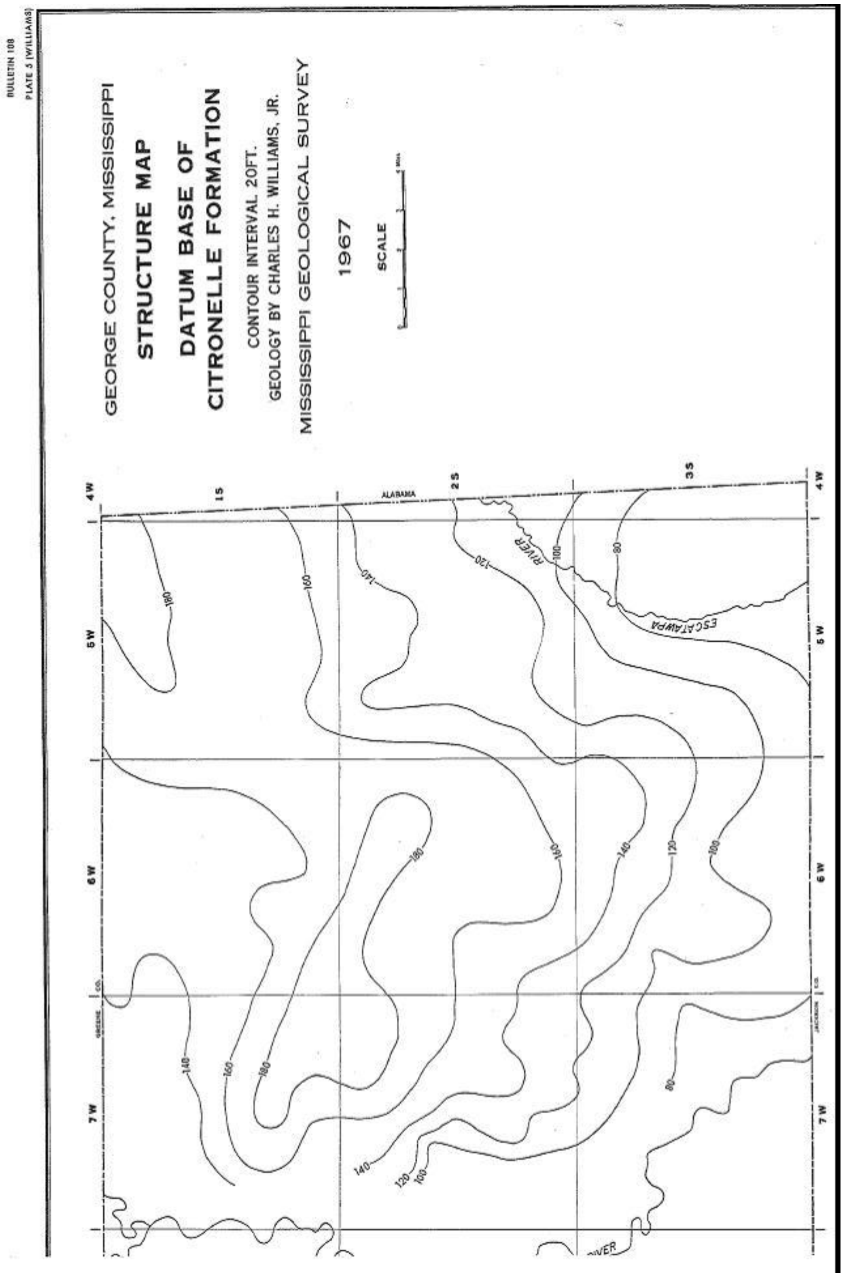
APPENDIX A

WILLIAM’S (1967) CONTOUR MAP OF SAND/CLAY CONTACT ZONE


BULLETIN 108
PLATE 5 (WILLIAMS)
GEORGE COUNTY, MISSISSIPPI
STRUCTURE MAP
DATUM BASE OF
CITRONELLE FORMATION
CONTOUR INTERVAL 20FT.
GEOLOGY BY CHARLES H. WILLIAMS, JR.
MISSISSIPPI GEOLOGICAL SURVEY
1967
SCALE
4 W
5 W
6 W
7 W
1 S
2 S
3 S
ALABAMA
RIVER
ESCATAWPA
GREENE
JACKSON
180
160
140
120
100
80

APPENDIX B

EXAMPLE OF MDOT WELL LOG DATA USED IN CROSS SECTIONS (PAGE #1)

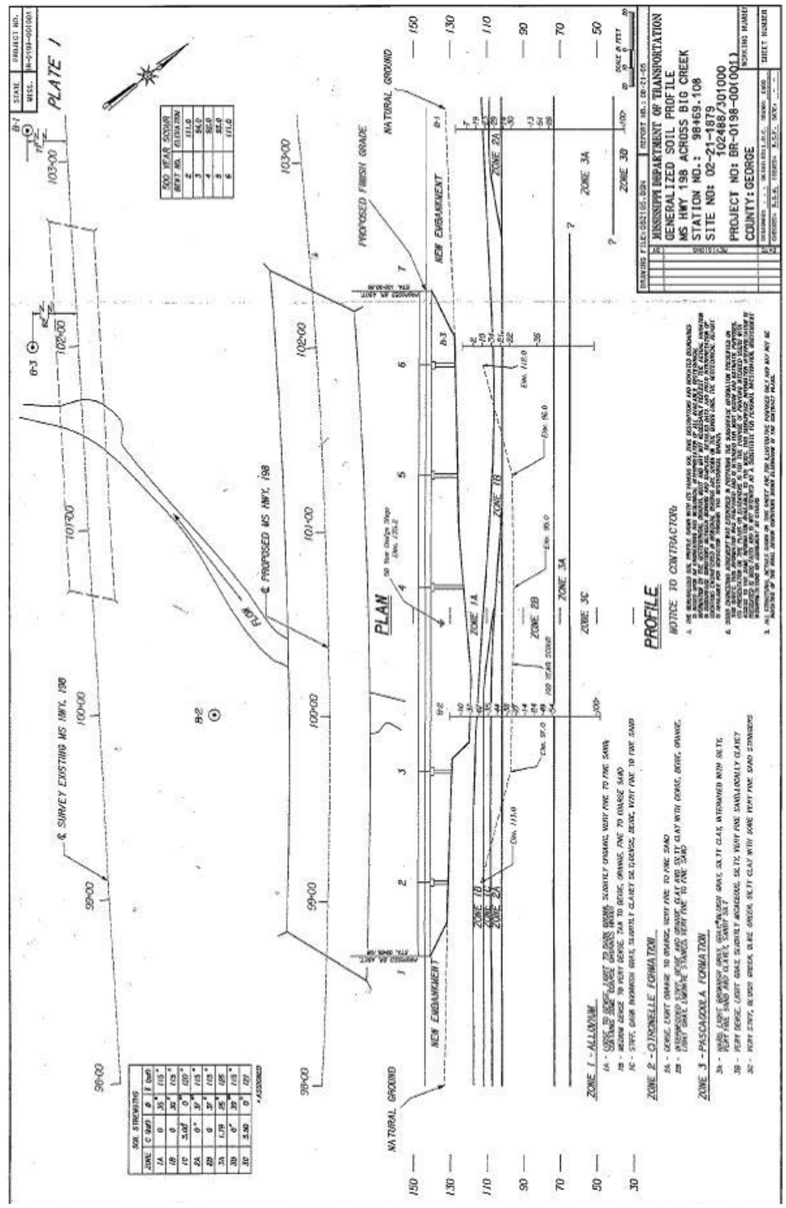


PLATE I
PLAN
PROFILE
NOTICE TO CONTRACTOR:
NATURAL GROUND
NEW EMBANKMENT
PROPOSED FINISH GRADE
℄ PROPOSED MS HWY. 198
℄ SURVEY EXISTING MS HWY. 198
SOIL STRENGTHS
500 YEAR SCOUR
MISSISSIPPI DEPARTMENT OF TRANSPORTATION
GENERALIZED SOIL PROFILE
MS HWY 198 ACROSS BIG CREEK
COUNTY: GEORGE

DRAWING NO.: 083105.DGN

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SITE NO.:02-21-1879	HOLE NO.:1	FMS P.E. NO.:102488/101000	REPORT NO: 082105
COUNTY: GEORGE	LATITUDE: N 30.94080°	LONGITUDE: W 88.81814°	COMPLETION DATE: 4/23/08
LOCATION: SR 198 @ BIG CREEK: BRIDGE NUMBER 205.8			WATER TABLE ELEVATION: N/A
STATION: 103+17	OFFSET: 71' LT. ℄ EXISTING SR 198		COMPLETION DEPTH: 92.0'
BORING TYPE: ROTARY WASH	LOGGED BY: FREDRICK TANNER		SURFACE ELEVATION: 126.99

COHESION, kip/sq ft: 1, 2, 3, 4
PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT: 20, 40, 60, 80

DEPTH, ft.	SAMPLES	DESCRIPTION OF MATERIAL	ZONE	BLOWS PER ft.	UNIT DRY WT. lb/cu ft	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT	ELEVATION, ft.
	T	@ 2' LOOSE, BROWN TO LIGHT BROWN SAND					
	S	@ 6' LOOSE, LIGHT GRAY TO GRAY, FINE TO MEDIUM SAND		7			
10							117.0
	S	@ 11' MEDIUM DENSE, DARK GRAY, FINE TO MEDIUM SAND	1A	19			
	S	@ 16' MEDIUM DENSE, LIGHT GRAY, FINE TO MEDIUM SAND	1B	23			
20							107.0
	S	@ 21' MEDIUM DENSE, TAN, FINE TO MEDIUM SAND	2A	29			
	S	@ 26' MEDIUM DENSE, TAN, FINE TO MEDIUM, CLAYEY SAND		14			
30							97.0
	S	@ 31' DENSE, TAN, FINE TO MEDIUM SAND		30			
	T	@ 36' SOFT, TAN TO LIGHT BROWN, FINE TO MEDIUM, SANDY CLAY					
40							87.0
	S	@ 41' MEDIUM DENSE, LIGHT GRAY TO TAN, FINE TO MEDIUM SAND		13			
	S	@ 46' DENSE, LIGHT GRAY TO TAN, FINE TO MEDIUM SAND		51			
50							77.0
	S	@ 51' MEDIUM DENSE, LIGHT BROWN, FINE TO MEDIUM SAND	2B	26			
	T	@ 56' HARD, DARK BLUE CLAY			97	VC=43%	
60							67.0
	T				107	VC=27%	
70							57.0
	T	@ 71' HARD, LIGHT BLUE CLAY			99	VC=60%	
80							47.0
	T	@ 81' HARD, LIGHT BLUE, SANDY CLAY	3A		111	VC=26%	
90							37.0
	S	@ 91' VERY DENSE, LIGHT GRAY, FINE TO MEDIUM SAND	3B	100+		VC=4%	
		TOTAL DEPTH OF BORING - 92.0'					
100							27.0
110							17.0

REV. 9/84 S: Split Spoon, T: Shelby Tube, C: Rock Core, P: Pitcher Sampler

PLATE: 23

DRAWING NO.: RR2105.DGN

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SITE NO.:02-21-1879	HOLE NO.:2	FMS P.E. NO.:102488/101000	REPORT NO: 082105
COUNTY: GEORGE	LATITUDE: N 30.94061'	LONGITUDE: W 88.6[illegible]'	COMPLETION DATE: 4/24/02
LOCATION: SR 198 2.8 MILES EAST OF US 98: BRIDGE NUMBER 206.9			WATER TABLE ELEVATION: N/A
STATION: 100+00	OFFSET: 62' RT. ℄ EXISTING SR 198		COMPLETION DEPTH: 82.0'
BORING TYPE: ROTARY WASH	LOGGED BY: FREDRICK TANNER		SURFACE ELEVATION: 130.27

DEPTH, ft.	SAMPLES	DESCRIPTION OF MATERIAL	ZONE	BLOWS PER ft.	UNIT DRY WT. lb/cu ft	COHESION, kip/sq ft (1, 2, 3, 4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, ft.
	S	@ 6' MEDIUM DENSE, DARK BROWN, FINE TO MEDIUM SAND		10			
10	S	@ 11' DENSE, TAN, FINE TO MEDIUM SAND	1A	37			120.3
	S	@ 16' DENSE, LIGHT GRAY, FINE TO MEDIUM SAND	1B	67			
20	S	@ 21' DENSE, DARK GRAY, FINE TO MEDIUM SAND	1C	35			110.3
	S	@ 26' DENSE, TAN, FINE TO MEDIUM SAND	2A	44			
30	S	@ 31' DENSE, TAN, FINE TO MEDIUM SAND		38			100.3
	S	@ 36' MEDIUM DENSE, TAN, FINE TO MEDIUM, CLAYEY SAND		27			
40	S			14			90.3
	S			24			
50	S	@ 51' DENSE, TAN TO LIGHT BROWN, FINE TO MEDIUM SAND WITH TRACES OF HEAVY MINERALS		49			80.3
	S		2B	54			
60	T	@ 61' VERY HARD, DARK BLUE CLAY	3A		106	WC=56%	70.3
70	T				96	WC=36%	60.3
80	S	@ 81' VERY DENSE SAND	3C	100+			50.3
		TOTAL DEPTH OF BORING - 82.0'					
90							40.3
100							30.3
110							20.3

REV. 9/84 S: Split Spoon, T: Shelby Tube, C: Rock Core, P: Pitcher Sampler

PLATE: 24

DRAWING NO.: 062105.DGN

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SITE NO.: 02-21-1879 | HOLE NO.: 3 | FMS P.E. NO.: 102488/101000 | REPORT NO: 062105

COUNTY: GEORGE | LATITUDE: N 30.96059° | LONGITUDE: W 88.61777° | COMPLETION DATE: 5/5/02

LOCATION: SR 198 @ BIG CREEK: BRIDGE NUMBER 206.9 | WATER TABLE ELEVATION: N/A

STATION: 102-00 | OFFSET: 68' LT. ℄ EXISTING SR 198 | COMPLETION DEPTH: 72.0'

BORING TYPE: ROTARY WASH | LOGGED BY: FREDRICK TANNER | SURFACE ELEVATION: 123.50

DEPTH, ft.	SAMPLES	DESCRIPTION OF MATERIAL	ZONE	BLOWS PER ft.	UNIT DRY WT. lb/cu ft	COHESION, kip/sq ft (1, 2, 3, 4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, ft.
	S	@ 6' VERY LOOSE, DARK GRAY, FINE TO MEDIUM SAND		2			
10	S			10			113.5
	S	@ 16' DENSE, DARK GRAY TO GRAY, FINE TO MEDIUM SAND	1A	34			
20	S	@ 21' MEDIUM DENSE, TAN TO LIGHT BROWN, FINE TO MEDIUM SAND	1B	21			103.5
	S			22			
30	T	@ 31' STIFF, GRAY CLAY					93.5
	T						
40	S	@ 41' DENSE, LIGHT GRAY, FINE TO MEDIUM SAND AND CLAY		35			83.5
	T	@ 46' FIRM, LIGHT GRAY, FINE TO MEDIUM, SANDY CLAY	2B				
50	T	@ 51' HARD, BLUE CLAY			105	VC=67%	73.5
	T		3A		105	VC=65%	
60	T				95	VC=56%	63.5
70	T	@ 71' VERY HARD, BLUE CLAY	3C		99	VC=68%	53.5
		TOTAL DEPTH OF BORING - 72.0'					
80							43.5
90							33.5
100							23.5
110							13.5

REV. 9/04 S: Split Spoon, T: Shelby Tube, C: Rock Core, P: Pitcher Sampler

PLATE: 25

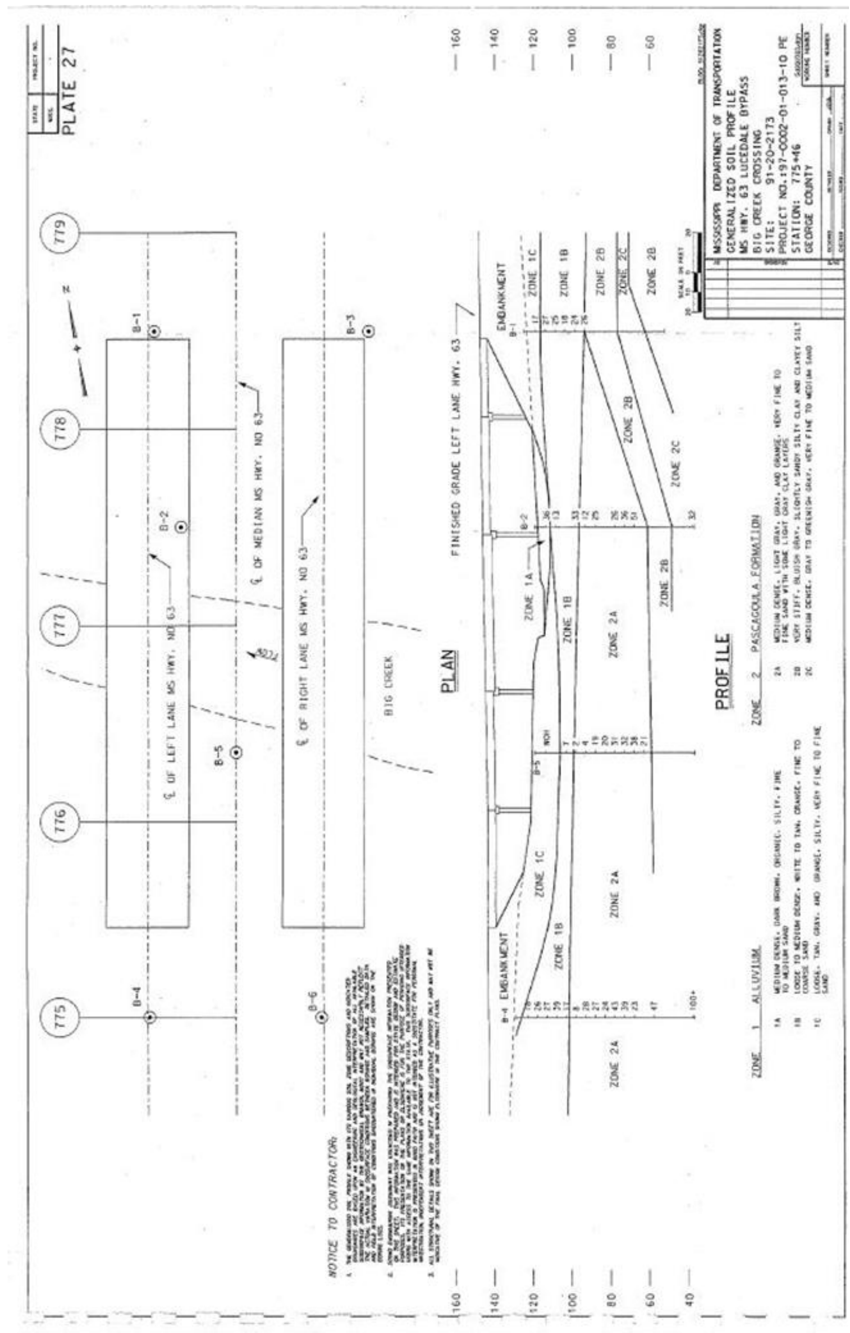


PLATE 27
MISSISSIPPI DEPARTMENT OF TRANSPORTATION
GENERALIZED SOIL PROFILE
MS HWY. 63 LUCEDALE BYPASS
BIG CREEK CROSSING
SITE: 91-20-2173
PROJECT NO. 197-0002-01-013-10 PE
STATION: 775+46
GEORGE COUNTY
PLAN
PROFILE
NOTICE TO CONTRACTOR:
BIG CREEK
FINISHED GRADE LEFT LANE HWY. 63
EMBANKMENT
ZONE 1 ALLUVIUM
ZONE 2 PASCAGOULA FORMATION

BORING LOG DRAWING NO.: 91202173.dgn

PROFILE DRAWING NO.: 58200302.dgn

LOG OF BORING NO. 91-20-2173-06
97-0002-01-016-10

TYPE: ROTARY WASH

LOCATION: STA. 776+00, 44' RT OF ℄ OF MEDIAN

SURFACE ELEV.: 128.2'

DEPTH, FT.	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT.	UNIT DRY WT. LB/CU FT	ELEVATION, FT.
	T	@ 5' LOOSE, WHITE, MEDIUM CLAYEY SAND			
10	S	@ 10' FIRM, ORANGE TO GRAY CLAYEY SAND			118.2'
	T	@ 12' STIFF, GRAY, MEDIUM SANDY CLAY			
	T				
	T				
	T	@ 18' SANDY			
20	T	@ 20' LOOSE, GRAY, MEDIUM CLAYEY SAND			108.2'
	T				
30	S	@ 30' LOOSE, WITH FINE GRAVEL	5		98.2'
	S	@ 35' MEDIUM DENSE	20		
40	S	@ 40' WHITE TO RUST	26		88.2'
	T	@ 45' STIFF, GRAY SANDY CLAY			
50	S	@ 50' DENSE, ORANGE, MEDIUM TO COARSE SAND	41		78.2'
	S		32		
60	S	@ 60' FINE GRAVEL	49		68.2'
70	S		34		58.2'
80	T	@ 80' CLAYEY SAND			48.2'
90					38.2'
		LOGGED BY: J.D. PHILLIPS			
100					28.2'

COHESION, KIP/SQ FT: 1, 2, 3, 4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 20, 40, 60, 80

COMPLETION DEPTH: 82'
DATE: 4-18-91

DEPTH TO WATER IN BORING: NOT DETERMINED
DATE: - -

S: Split Spoon T: Shelby Tube PLATE: 49

BORING LOG DRAWING NO.: 91202173.dgn

PROFILE DRAWING NO.: 5d200302.dgn
PROFILE DRAWING NO.: 5d200303.dgn

LOG OF BORING NO. 91-20-2173-05
97-0002-01-016-10

TYPE: ROTARY WASH

LOCATION: STA. 776+35, ℄ OF SURVEY

SURFACE ELEV.: 119.2'

DEPTH, FT.	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT.	UNIT DRY WT. LB/CU FT	COHESION, KIP/SQ FT (1, 2, 3, 4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, FT.
	S	@ 5' VERY LOOSE, WHITE, MEDIUM SAND	WOH			
		CLAY				
10	T	@ 10' MEDIUM DENSE, GRAY, MEDIUM CLAYEY SAND				109.2'
	S	@ 15' LOOSE, GRAY TO WHITE, MEDIUM TO COARSE SAND	7			
20	S	@ 20' VERY LOOSE SAND	2			99.2'
	S		4			
30	S	@ 30' MEDIUM DENSE	19			89.2'
	S	@ 35' WHITE TO RUST, SAND WITH FINE GRAVEL	20			
40	S	@ 40' DENSE	31			79.2'
	S	@ 45' IRONSTONE	32			
50	S	@ 50' RUST TO GRAY WITH IRONSTONE	38			69.2'
	S	@ 55' MEDIUM DENSE	21			
60	T	@ 60' CLAYEY LAYERS		96	N.P.	59.2'
70	T	@ 70' CLAYEY SAND		111	N.P.	49.2'
80	T	@ 80' VERY STIFF, GRAY, SANDY SILTY CLAY		94	N.P.	39.2'
90						29.2'
100		LOGGED BY: J.D. PHILLIPS				19.2'

COMPLETION DEPTH: 82'
DATE: 4-16-91

DEPTH TO WATER IN BORING: NOT DETERMINED
DATE: - -

S: Split Spoon T: Shelby Tube PLATE: 48

BORING LOG DRAWING NO.: 91202173.dgn — PROFILE DRAWING NO.: 6d200308.dgn

LOG OF BORING NO. 91-20-2173-04
97-0002-01-016-10

TYPE: ROATARY WASH — LOCATION: STA 775+00, 44' LT OF ℄ OF MEDIAN

SURFACE ELEV.: 128.8'

DEPTH, FT.	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT.	UNIT DRY WT. LB/CU FT	ELEVATION, FT.
		WASHING			
	S	@ 5' MEDIUM DENSE, ORANGE, MEDIUM TO COARSE SAND	18		
		CLAY			
10	S	@ 10' MEDIUM DENSE, ORANGE, MEDIUM TO COARSE SAND	26		118.8'
	S	@ 15' LIGHT YELLOW TO RUST	27		
20	S	@ 20' DENSE, ORANGE TO WHITE	39		108.8'
	S	@ 25' GRAY TO WHITE	17		
30	S	@ 30' LOOSE, CLAYEY WITH FINE GRAVEL	8		98.8'
	S	@ 35' MEDIUM, DENSE SAND	20		
40	S		27		88.8'
	S	@ 45' BROWN SAND	24		
50	S	@ 50' DENSE SAND	43		78.8'
	S		39		
60	S	@ 60' MEDIUM DENSE SAND	23		68.8'
70	S	@ 70' DENSE SAND	47		58.8'
80	T	@ 80' GRAY, CLAYEY			48.8'
90	S	@ 90' VERY DENSE SAND	100+		38.8'
100		LOGGED BY: J.D. PHILLIPS			28.8'

COHESION, KIP/SQ FT: 1 2 3 4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 20 40 60 80

COMPLETION DEPTH: 92'
DATE: 4-18-91

DEPTH TO WATER IN BORING: NOT DETERMINED
DATE: - -

S: Split Spoon — T: Shelby Tube — PLATE: 47

BORING LOG DRAWING NO.: 91202173.dgn PROFILE DRAWING NO.: 5d200302.dgn

LOG OF BORING NO. 91-20-2173-03
97-0002-01-016-10

TYPE: ROTARY WASH LOCATION: STA. 779-50, 66' RT OF ℄ OF MEDIAN

DEPTH, FT.	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEV.: 121.0'	BLOWS PER FT.	UNIT DRY WT. LB/CU FT	COHESION, KIP/SQ FT (1, 2, 3, 4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, FT.
	S	@ 5' MEDIUM DENSE, MEDIUM TO COARSE SAND	23			
10	S		14			111.0'
	S	FIRM, GRAY, MEDIUM SANDY CLAY	5			
20	S	VERY LOOSE, LIGHT GRAY, MEDIUM SILTY SAND	3			101.0'
	S	CLAY	3			
30	T	@ 30' MEDIUM DENSE, GRAYISH GREEN, MEDIUM SILTY SAND				91.0'
	T	@ 35' VERY STIFF, GREENISH GRAY, CLAYEY SILT		81	N.P.	
40	T	@ 40' HARD SANDY SILT		74		81.0'
	T			84		
50	T	@ 50' SANDY		84	N.P.	71.0'
	T	@ 55' MEDIUM DENSE, GRAY, MEDIUM SILTY SAND				
		SAND				
60	T S	@ 60' VERY STIFF, GRAY, CLAYEY SILT	16			61.0'
70	S	@ 70' DENSE, GRAY, MEDIUM SAND WITH CLAY LAYERS	31			51.0'
80						41.0'
90		LOGGED BY: J.D. PHILLIPS				31.0'
100						21.0'

COMPLETION DEPTH: 71.5 DEPTH TO WATER IN BORING: NOT DETERMINED

DATE: 4-10-91 DATE: - -

S: Split Spoon T: Shelby Tube PLATE: 46

BORING LOG DRAWING NO.: 91202173.dgn

PROFILE DRAWING NO.: 5d200302.dgn
PROFILE DRAWING NO.: 5d200303.dgn

LOG OF BORING NO. 91-20-2173-02

97-0002-01-016-10

TYPE ROTARY WASH

LOCATION: STA. 777+60, 28' LT OF ℄ OF MEDIAN

SURFACE ELEV.: 110.8'

DEPTH, FT.	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT.	UNIT DRY WT. LB/CU FT	COHESION, KIP/SQ FT (1, 2, 3, 4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, FT.
	S	@ 5' DENSE, FINE TO MEDIUM SILTY SAND W/ORGANICS	36			
10	S	@ 10' MEDIUM DENSE, MEDIUM TO COARSE WHITE SAND	13			100.8'
	T	@ 15' FIRM, GRAY, MEDIUM SANDY CLAY				
20	S	@ 20' DENSE, WHITE TO RUST, MEDIUM TO COARSE SAND, SOME FINE GRAVEL	33			90.8'
	S	@ 25' MEDIUM DENSE	12			
30	S	@ 30' CLAYEY	25			80.8'
	T	@ 35' FIRM, GRAY CLAY WITH SAND LAYERS				
40	S	@ 40' MEDIUM DENSE, BROWN, MEDIUM TO COARSE CLAYEY SAND	26			70.8'
	S	@ 45' DENSE	36			
50	S	52' TO 54' CLAY LAYERS	51			60.8'
	T	@ 55' DENSE, SILTY SAND				
60	T	@ 60' VERY STIFF, GRAY CLAYEY SILT		77	N.P.	50.8'
		63' TO 65' SAND LAYERS				
70	T	@ 70' SANDY				40.8'
80	S	@ 80' DENSE, GRAY, MEDIUM SAND	32			30.8'
90						20.8'
100		LOGGED BY: J.D. PHILLIPS				10.8'

COMPLETION DEPTH: 81.5'

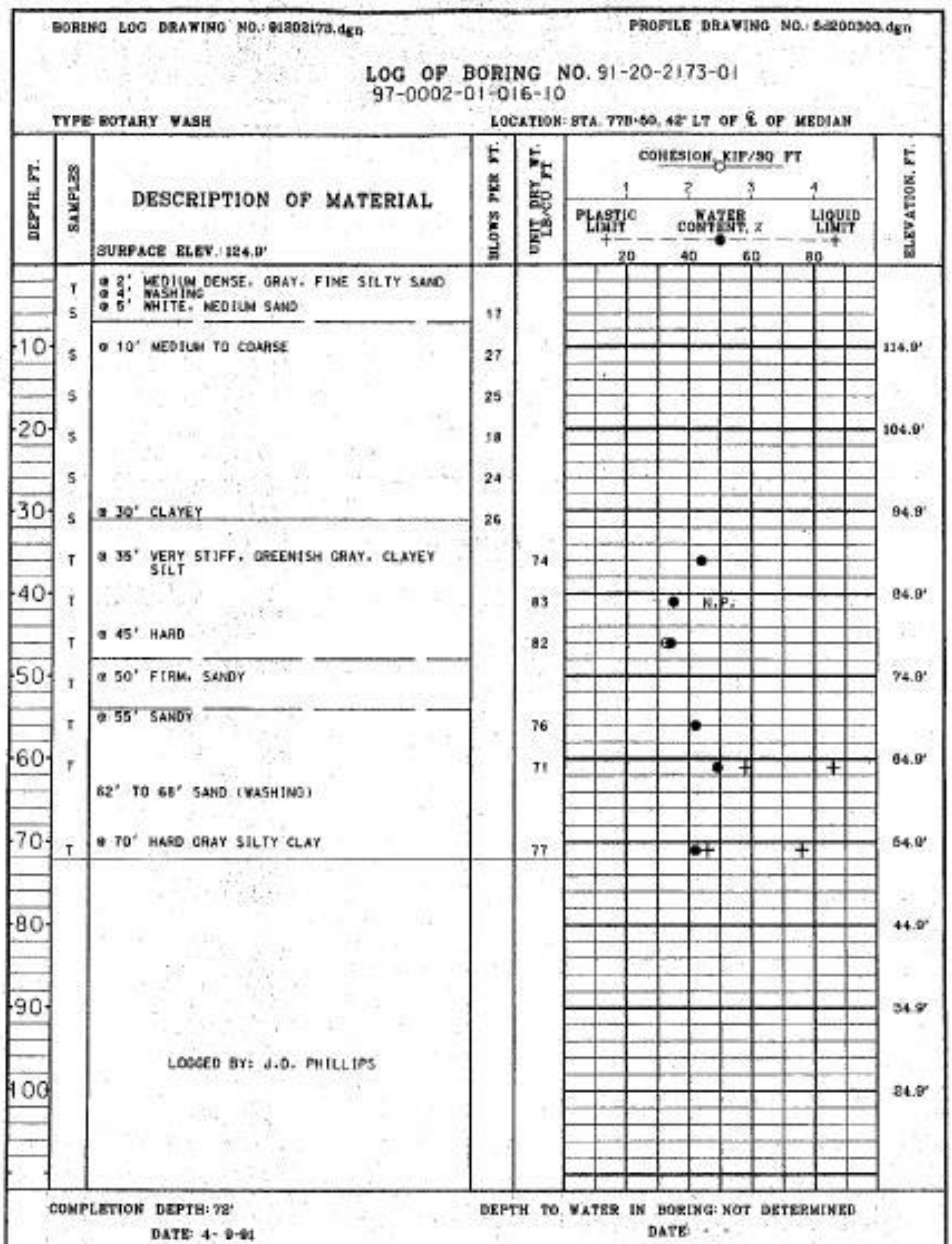
DATE: 4-9-91

DEPTH TO WATER IN BORING: NOT DETERMINED

DATE: - -

S: Split Spoon   T: Shelby Tube

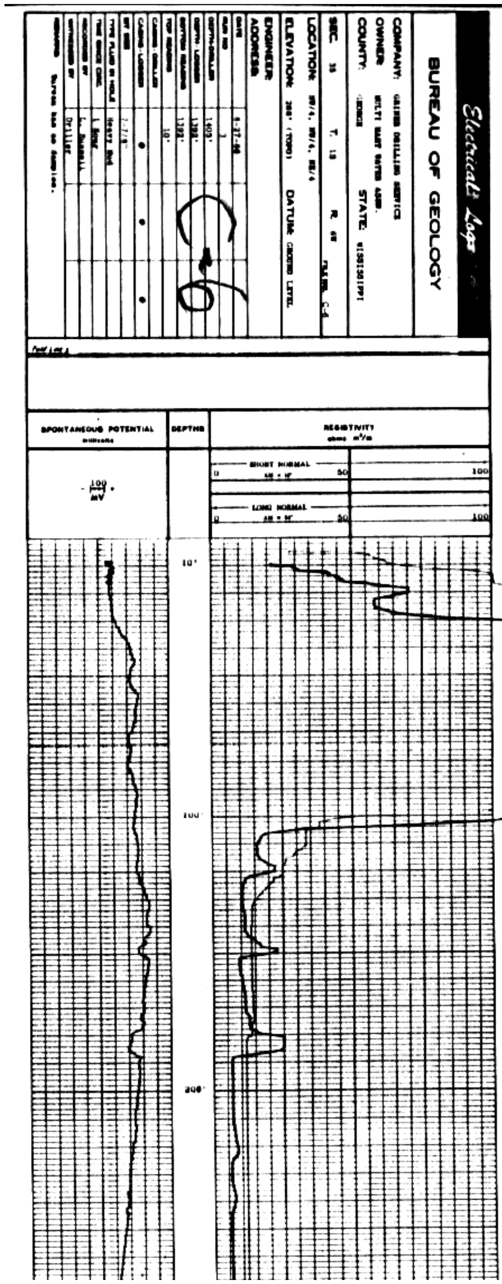
PLATE: 45

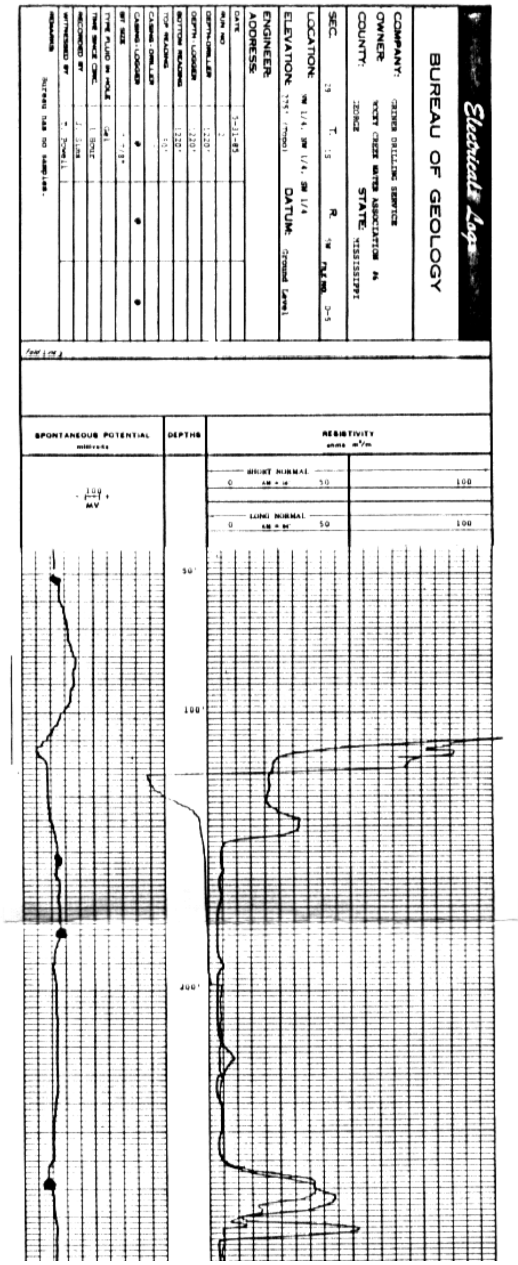


S: Split Spoon T: Shelby Tube

APPENDIX C

GEOPHYSICAL LOG DEPICTING RESISTIVITY KICK FOUND AT SAND/CLAY CONTACT ZONE WITHIN THE STUDY AREA


BUREAU OF GEOLOGY
COMPANY:
OWNER:
COUNTY:
STATE:
SEC.
LOCATION:
ELEVATION:
DATUM:
ENGINEER:
ADDRESS:
C-6
SPONTANEOUS POTENTIAL
DEPTHS
RESISTIVITY
SHORT NORMAL
LONG NORMAL
100
200'


Electrical Log
BUREAU OF GEOLOGY
COMPANY:
OWNER:
COUNTY:
STATE: MISSISSIPPI
SEC.
LOCATION:
ELEVATION:
DATUM: Ground Level
ENGINEER:
ADDRESS:
SPONTANEOUS POTENTIAL
DEPTHS
RESISTIVITY
SHORT NORMAL
LONG NORMAL
50'
100'
200'

APPENDIX D

EXAMPLE OF DRILLERS LOG USED TO DETERMINE SAND/CLAY CONTACT ZONE

County: George

Permit #:

Driller: Michael S. Harard

Date drilling completed: 10-20-06

State Well Report

Part 1

Mississippi Department of Environmental Quality
Office of Land and Water Resources
P.O. Box 10631
Jackson, MS 39289-0631
(601)961-5210
(601)354-6938 (fax)

For Office Use Only:

Aquifer:

Well #: L-151

L. S. Elevation:

E-log #:

State Law requires that this report be prepared by the driller in detail and filed with the Department within 30 days of completion of drilling of the well.

Well Owner Information

Owner Name: Richard Maskew

Mailing Address: 195 Wayne Lee Rd

Lucede MS 39452
City State Zip Code

Telephone No. (601) 508-4710

Well Location

Latitude: 30 ° 48 ' 63 " Longitude: 88 ° 35 ' 42 "

Method of Lat/Long (circle one): Conventional Survey, USGS quad, Hand-held GPS, Survey-grade GPS

___ ¼ ___ ¼ Sec 4 Twn 73S Rng R6W

Distance 4.5 Miles Direction S of Nearest Town Lucedale

Well Data

Purpose of Well (circle one): Home Industrial Public Supply Irrigation Fish Culture Other:

Date well drilling started: 10-20-06 Date well drilling completed: 10-20-06

If flowing, method of flow regulation: Valve ______ Other (describe)

Static Water Level: 55 feet above or below (circle one) land surface Date measured: 10-20-06

Method of Measurement (circle one) steel tape electric tape air line other:

Hole depth: 115 Well depth: 115 Well grouted to a depth of 18 feet

Type of grout (circle one): Cement Bentonite Mix

Casing length: 105 feet Casing diameter: 2 inches Type of casing: PVC S40

Screen length: 10 feet Screen diameter: 2 inches Type of screen: WOP PVC

Screen slot size: .006 inches Setting depth: From 105 feet to 115 feet

Type of completion (circle all applicable): Gravel packed Underreamed Telescoped Open hole Natural Development

Other (describe):

Top of lap pipe or reduction in casing: ______ feet. **If telescoped or more than one screen, describe on back of page**

Logs run (circle all applicable): No log run Electric Gamma Ray Density Sonic Neutron Other:

Name of organization running log(s):

I certify that the well was drilled, constructed, and completed in accordance with all applicable requirements of the Mississippi Department of Environmental Quality and/or the Mississippi Department of Health regulations and state laws.

Michael S. Harard D-673

Print Name of Water Well Contractor and License No.

Signature of Water Well Contractor

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NOV 22 2006
BY: OLWR

L-151

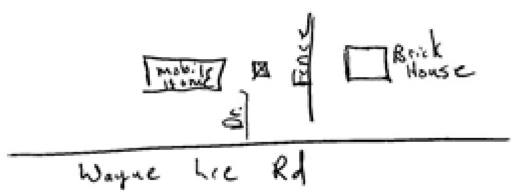
If well telescopes please sketch below and show depths.

Ground Level

Description of Formations Encountered	From	To
Topsand	0	10
Sand	10	15
Clay	15	65
Silt	65	72
Sand, fine - med	72	95
Clay	95	96
Sand, med	96	115

If more than one screen, show location of each on sketch

Sketch the property layout and include the following: 1) the well location; 2) any permanent structures on the property that may aid in locating the well; 3) any roads, power lines, or other items that may aid in locating the property and the well; 4) indicate direction.



Landowner Name: Richard Maskew

Signature of Water Well Contractor

RECEIVED
NOV 22 2006
BY: OLWR

APPENDIX E

GPS SPRING LOCATIONS

Longitude	Latitude	ID	
-88.6358	30.9498	SPB 1001	
-88.6023	30.9251	SPB1002	
-88.5677	30.9138	SPC 1019	
-88.5719	30.9177	SPC 1020	
-88.5902	30.9320	SPC 1021	
-88.5819	30.9205	SPC1003	
-88.5841	30.9193	SPC1004	
-88.5855	30.9275	SPC1005	
-88.5844	30.9278	SPC1006	
-88.5828	30.9267	SPC1007	
-88.5918	30.9333	SPC1008	
-88.5945	30.9320	SPC1009	
-88.5937	30.9337	SPC1010	
-88.5803	30.9243	SPC1011	
-88.5776	30.9227	SPC1012	
-88.6004	30.9537	SPC1013	
-88.6045	30.9539	SPC1014	
-88.6079	30.9548	SPC1015	
-88.6128	30.9556	SPC1016	
-88.6197	30.9571	SPC1017	
-88.6465	30.8913	SPC1018	
-88.5773	30.8602	SPF 1001	
-88.5761	30.8856	SPG1001	
-88.5530	30.8352	SPG1002	
-88.5453	30.8421	SPG1003	
-88.5629	30.8737	SPG1004	
-88.5622	30.8738	SPG1005	
-88.5318	30.8517	SPG1006	
-88.5320	30.8519	SPG1007	
-88.5337	30.8544	SPG1008	
-88.5596	30.8700	SPG1009	
-88.5593	30.8709	SPG1010	
-88.5579	30.8711	SPG1011	
-88.5725	30.8675	SPG1012	
-88.5797	30.8681	SPG1013	
-88.5773	30.8754	SPG1014	
-88.5792	30.7403	SPG1015	
-88.5259	30.7766	SPL1002	
-88.5319	30.7799	SPL1003	
-88.5179	30.7759	SPL1004	